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New Zealand Geographer

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THE LOCATION OF MANUFACTURING IN NEW ZEALAND*

G. J. R. LINGE

ALTHOUGH 155,000 persons, or 19.2 percent of the employed population of New Zealand,[1] are engaged in manufacturing activities, little work has been done by geographers on the dominion's manufacturing industries. Only one has made a major contribution.[2] The classifications of manufacturing proposed in that study have not been re-examined in the light of the continued expansion which has taken place in secondary industry since the war. The present author has therefore made a general appraisal of manufacturing in the dominion, and in particular, has made an investigation of theoretical concepts which may be generally applicable to the study of manufacturing. This paper seeks first to review the general character of manufacturing in New Zealand and secondly to consider the concept of the 'location factor' and its use in studies of the distribution of manufacturing activity.[3] The main criterion of manufacturing used is employment; and whilst the use of a single criterion is not ideal, of all the criteria and combinations of criteria which have been suggested for measuring the distribution and importance of manufacturing between various areas within a country, employment is the only one for which data in sufficient detail are available in New Zealand.

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*This paper forms part of a larger study of manufacturing in New Zealand made possible by financial assistance provided by the Goldsmiths Company of London which is hereby gratefully acknowledged.

[1] All statistics, unless otherwise stated, are based on the Annual Factory Registration by the Department of Labour and Employment of March 1956. These have been made available by this department by employment districts, a list of which appears in the caption to Figure 1. The additional statistics used have been derived by the author from this basic information.

[2] J. L. Hewland: 'Manufacturing in New Zealand: Its Outstanding Characteristics', *N.Z. Geographer*, Vol. 2, No. 1, April 1946, pp. 207-222.

[3] The definition of manufacturing adopted here is narrower than that used by the Department of Labour and Employment, which includes codes 110 to 540 of the National Employment Service Industrial Classification within its published statistics for manufacturing. In the present discussion codes 170 (cake and pastry kitchens), 390 (shoe repairing), and 520 (vehicle repair and maintenance), are excluded, as are naval dockyards, railway workshops, and public utilities. A useful definition of 'manufacturing' is 'any process by which raw or partly-processed materials are turned into a more useful form, and where the place it is carried on is a matter of choice.'

Manufacturing activities have been carried on in New Zealand since the first settlers arrived—in fact some of the earliest immigrants were selected because they were artisans and would be able to take up their trades on arriving in the new colony. The first industries were concerned with supplying local needs, food, drink, houses, footwear and clothing. The first printing press was set up at the Bay of Islands in 1834, whilst the first dockyard was established at Hokianga in 1827. Gradually other industries were developed, such as woollen manufacture and tanning. When refrigeration was used to transport meat and dairy products across the world, industries concerned with the processing of such products rapidly became of first importance. World War I and the world-wide depression of the 'thirties both gave further encouragement to the development of secondary industries.

1936–1945

The modern development of manufacturing in New Zealand dates from 1936 with the introduction of the Industrial Efficiency Act, which was designed to promote new industries and achieve a greater measure of industrial efficiency. Together with the customs tariff and later the control of imports by licensing, the act protected industries for which it made provision. Import licensing was established late in 1938 to correct a fall in overseas funds and the drain of capital from the country. All imports were prohibited, a licence having to be obtained before the Reserve Bank could be approached to authorise the expenditure of overseas funds. In this way existing manufacturers became, in many cases, the sole suppliers of manufactured goods, and accordingly they were able to take advantage of very favourable conditions. Not only were local firms able to expand, but overseas companies found it advantageous to set up factories in New Zealand, or have their branded goods manufactured in the dominion by existing firms under licence.

With the outbreak of war, military needs were predominant, and controls were introduced to maintain and increase the production of 'essential' industries. Of particular importance was the control of manpower and its direction into particular industries. The export industries maintained close liaison with the needs of Britain, and year by year emphasis was placed on food and raw materials in short supply. In this way the flax industry was expanded at the request of the United

Kingdom to overcome the shortage of materials for aeroplane fabric. A further stimulus was provided by lease-lend agreements to supply food and equipment to United States and other allied troops in the Pacific.

The Postwar Decade

After the war there was a return to manufacturing for civilian needs. As might have been expected there was a backlog of demand created by the scarcities of wartime. New skills had been developed, and these were now concentrated on the manufacture of a larger range of goods than had been possible during or before the war. The rapid rate of growth of population, the expansion of state housing schemes and the development of new industrial areas and residential suburbs all contributed to the demand for greater production of a more varied range of products. There was a development of industries assembling a combination of local and imported components. In particular, the growing range of home appliances provided work for factories specialising in the manufacture of components.

New Zealand industry—in common with that of most countries in the world—was handicapped after the war by shortages of manpower and materials. But whilst by 1950 many raw materials had become easier to obtain, the shortage of manpower persisted. A flood of imported consumer goods followed a relaxation of import controls in 1950, and local industry suffered a setback from increased competition. During the years that followed exchange controls and credit restrictions were reintroduced, relaxed temporarily, and again imposed in 1955.

Extent of Manufacturing

Manufacturing has become an integral part of the economy of New Zealand. Of 154,921 persons employed in manufacturing activities, 115,509 are males and 39,412 females, and they work in 10,334 factory units.[4] With nearly twenty percent of all employed persons, manufacturing shows a remarkably high proportion in view of the stage of development of the New Zealand economy and the relatively short history of industry. By comparison, 137,000 persons, or seventeen per-cent of all employed workers, are engaged in farming. In terms of their contributions to the net national income (at factor cost) farming and manufacturing are now very similar. For the first time in 1953-1954 manufacturing contributed a slightly higher total than farming with £183 million out of a national total of £732 million.

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[4] Some 200,000 persons, or 24.8 percent of the working population, are engaged in 'manufacturing' activities if all employment codes as used by the Department of Labour and Employment are included. In code 520 alone, covering vehicle repair and maintenance, 20,000 persons are employed. The Factories Act of 1946 defines a factory as 'any building, office, or place in which two or more persons are employed, directly or indirectly in any handicraft or in preparing or manufacturing goods for trade or sale. . . .' The act also includes one-man businesses where steam, mechanical power or appliances, or electrical energy for motive power is used. It expressly includes abattoirs, bakehouses and handicrafts of a noxious character.

TABLE I

EMPLOYMENT AND FACTORIES IN EACH OF NINE SIZE-GROUPS

Size-Groups by Number of Workers	Factory Workers Employed 1953		Factory Units 1956	
	Number	Percentage	Number	Percentage
1–2	5,424	4.1	2,867	27.7
3–5	10,648	8.0	2,992	29.0
6–10	14,700	11.1	1,870	18.1
11–20	16,835	12.7	1,220	11.8
21–50	24,237	18.3	885	8.6
51–100	15,987	12.0	302	2.9
101–200	12,704	9.6	105	1.0
201–500	19,270	14.5	63	0.6
Over 500	13,031	9.8	30	0.3
New Zealand Total	132,836	100.0	10,334	100.0

SCALE OF MANUFACTURING

One of the outstanding features of manufacturing in the dominion is the very large number of small units. The percentage of workers in each of nine size-groups of factory in 1953 is shown in Table 1. For comparison, the percentage of units in each size-group in 1956 has also been shown.[5]

In 1956, three-quarters of all manufacturing units had less than eleven employees, but there still remained 2,605 units with more than this number of workers. In 1953, forty-five percent of all workers were employed in units having more than 50 employees, and the size-groups

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[5] The comparison seems justified in that no significant changes have occurred during the intervening period to alter these proportions substantially. The year 1953 was the last in which the Department of Labour and Employment collected figures from which such proportions could be calculated.

21-50 and 201-500 both had larger proportions of the total workers than the other size-groups. The size-group 1-2 had the smallest share, whilst the other six size-groups had a more or less equal share of the remaining workers.

Whilst the size of factories is small in terms of the numbers employed, as compared with the more highly industrialised countries, at the same time the size of the market which they supply is also small by overseas standards. The tendency to invest in expensive plant and machinery in order to make a product to compete with one made in more highly industrialised countries means that a relatively small staff can run a highly capitalised plant. It is a mark of the youthfulness of manufacturing that many factories continue to produce a highly diversified range of products. Only in recent years has there been a tendency towards more specialised, and generally more efficient, production.

The most usual factory-size varies considerably from industry to industry. For example, 1-5 employees is usual for jewellery and instrument making, 3-11 employees in bread baking, and more than 500 in meat freezing works. Difficulties are involved in defining the most usual size of factory within an industry, for there are often relatively few undertakings scattered throughout the size-ranges. Short-term fluctuations in the numbers employed are particularly marked in the seasonal industries processing primary products, such as meat freezing and cheese and butter making. Some factories engaged in the fruit and vegetable preserving industry close down altogether in the off-season. Longer term fluctuations, caused by changing economic conditions, can be detected in most industries. Such, for example, are alterations of government policy on the importation of manufactured goods which compete with local products.

Employment by Industries

New Zealand is not adequately endowed with the raw materials necessary for the development of heavy industry. Suggestions have been made from time to time for the utilisation of local iron ore and ironsands, but attempts to establish such an industry have hitherto failed. The principal industries are those handling the produce of the pastoral industries. The meat works, dairy factories, canning plants, and saw-mills together employ one-fifth of all workers in manufacturing.

Published statistics are readily available[6] showing the numbers of workers employed, and other details, in individual industries throughout the dominion. Table 2 outlines in summary form the proportion of workers employed in broad groups of manufacturing activity.

TABLE 2

WORKERS EMPLOYED IN VARIOUS MANUFACTURING ACTIVITIES 1956

Percentage of Total Workers in Manufacturing	Manufacturing Group
More than 5.0	Engineering (13.4), Clothing (13.0), Meat Freezing (12.3), Printing and Allied Trades (5.3).
3.0–4.9	Sawmilling and Plywood (3.9), Vehicle and Cycle Manufacture and Assembly (3.4), Dairy Products (3.3), Chemicals inc. Fertilisers (3.3), Furniture and Cabinetmaking (3.2), Footwear (3.2), Electrical Goods (3.1), Builder's Woodwork (3.0).
1.0–2.9	Knitted Wear and Hosiery (2.7), Lime and Cement (2.5), Rubber (1.8), Woollens (1.6), Sugar and Confectionery (1.5), Beverages (1.5), Fruit and Vegetable Preserving (1.5), Paper and Paper Products (1.4), Tanning (1.0), Bricks, Tiles and Stoneware (1.0), Biscuits (1.0).
Less than 1.0	Pottery and Glass (0.9), Tobacco (0.8), Jewellery and Instrument (0.7), Boatbuilding (0.7), Grain Milling (0.4), Flax, Rope and Twine (0.2).

Forty-four percent of all workers are shown to be employed in general engineering works, clothing factories, meat freezing works or printing works. No other activity employs more than four percent of the total, whilst at the other extreme three groups—grain milling; case, crate and barrel making; and flax, rope and twine making establishments—employ less than 1,000 workers each. Six industries employ more than sixty-five percent of all female workers in manufacturing. The manufacture of clothing has the greatest share with 41 percent; the other industries are knitwear and hosiery (6.5 percent), footwear (5.4), printing (4.8), engineering (4.0) and chemicals (3.1). No other industry employs more than two percent of the total of females.

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[6] *Census of Factory Production*, Wellington (annual).

Distribution of Manufacturing

Of the employment districts Auckland, with 29.9 percent, has twice as many workers in manufacturing industry as any other. Christchurch, Wellington, Dunedin and Lower Hutt together account for another third of all workers.[7] The North Island has by far the greater share of workers engaged in manufacturing activities with 68.8 percent.

Auckland, Wellington, Christchurch and Dunedin are almost the only districts in which the percentage of the total female workers is greater than the percentage of total male workers, and this is illustrated in Figure 1. The only other exception is the Greymouth district, which can be explained by the large number of males employed in primary industries especially coal-mining and sawmilling. The districts in which the four main centres are situated employ 73.5 percent of all female workers in manufacturing. This is a reflection of the fact that the industries in which the majority of females are employed are concentrated in the main urban areas.[8]

The distribution of factory units employing more than 50 workers is shown in Figure 2. Four size-groups have been shown (51-100, 101-200, 201-500, and over 500) and again the predominance of the four main districts, together with Lower Hutt, is clearly illustrated. Differences in the scales of manufacturing in the districts are marked. Whereas Lower Hutt has a large number of units in the upper size-groups, Wellington has only a few large units, but many smaller ones. Whilst Christchurch has seventeen factories employing between 200-500 workers, Auckland has only fifteen. The growth of Christchurch as the second manufacturing centre is sometimes overlooked. It is one of the most significant changes in New Zealand manufacturing since before the war. Dunedin was the home of many of the early industries, and even today companies with factories in the other main centres have head offices in this city. Dunedin however has attracted few new industries and has lost its early dominance as the main manufacturing centre.

It is noticeable that thirteen out of thirty factories in the largest size-group are not in the five main districts. All but two of these are meat freezing works, which are, as might be expected, widely dispersed. The growing significance of industries dependent on forest products is indicated by the large factories in the Rotorua district. Whilst the Whakatane Board Mills have been in operation since 1939, the other

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[7] The percentages for these districts are, respectively, 15.0, 8.9, 7.7 and 5.9.

[8] The four districts account for 87.2 percent of all workers in the footwear trade, 79.8 in knitwear and hosiery, 76.6 in clothing, and 74.5 in the printing trade.

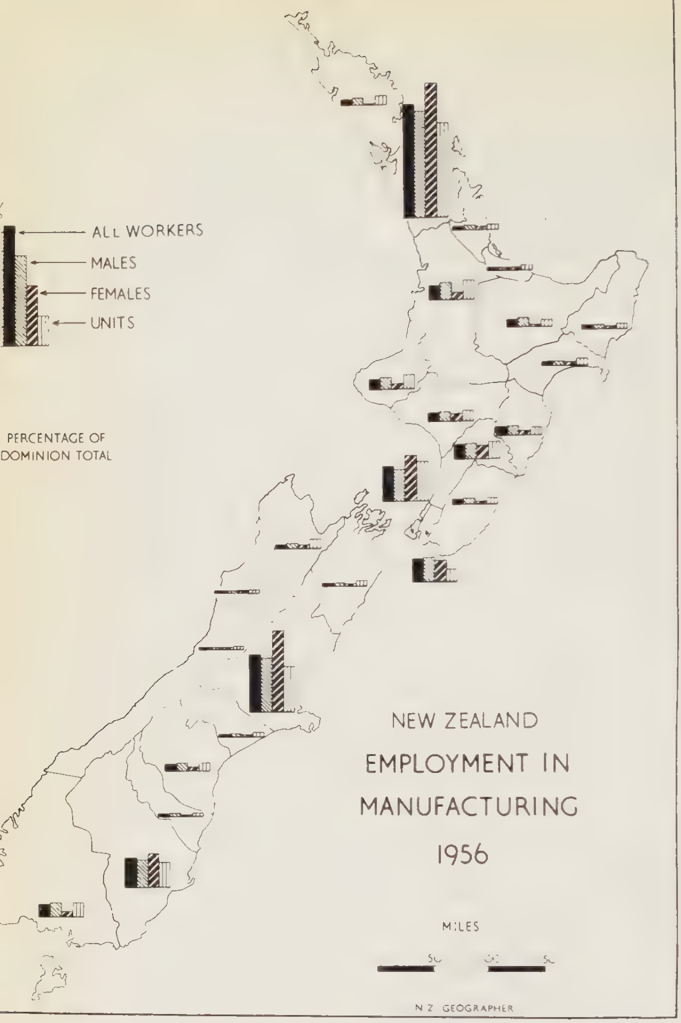


Fig. 1.
Percentage of workers (males, females and all workers) and of manufacturing establishments by employment districts, 1956.

North Island
1. Auckland
2. Whangarei
3. Hamilton
4. Paeroa
5. Tauranga
6. Rotorua
7. Gisborne
8. Napier
9. Hastings
10. New Plymouth
11. Wanganui
12. Palmerston North
13. Masterton
14. Lower Hutt
15. Wellington

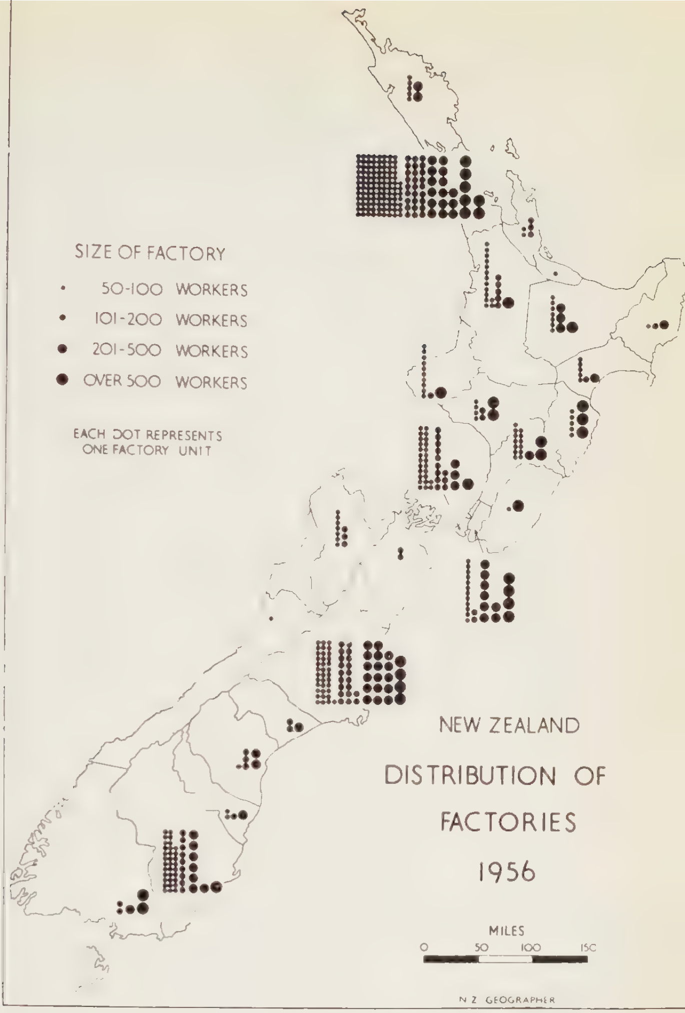
South Island
16. Blenheim
17. Nelson
18. Westport
19. Greymouth
20. Christchurch
21. Ashburton
22. Timaru
23. Oamaru
24. Dunedin
25. Invercargill

plants are of recent development. The chemical pulp and kraft paper plant of New Zealand Forest Products at Kinleith has operated since 1954, newsprint from Kawerau—established by the Tasman Pulp and Paper Company—first became available in 1955, and tissue paper was first manufactured at the Caxton Paper Mills in 1956.

Changes in Location

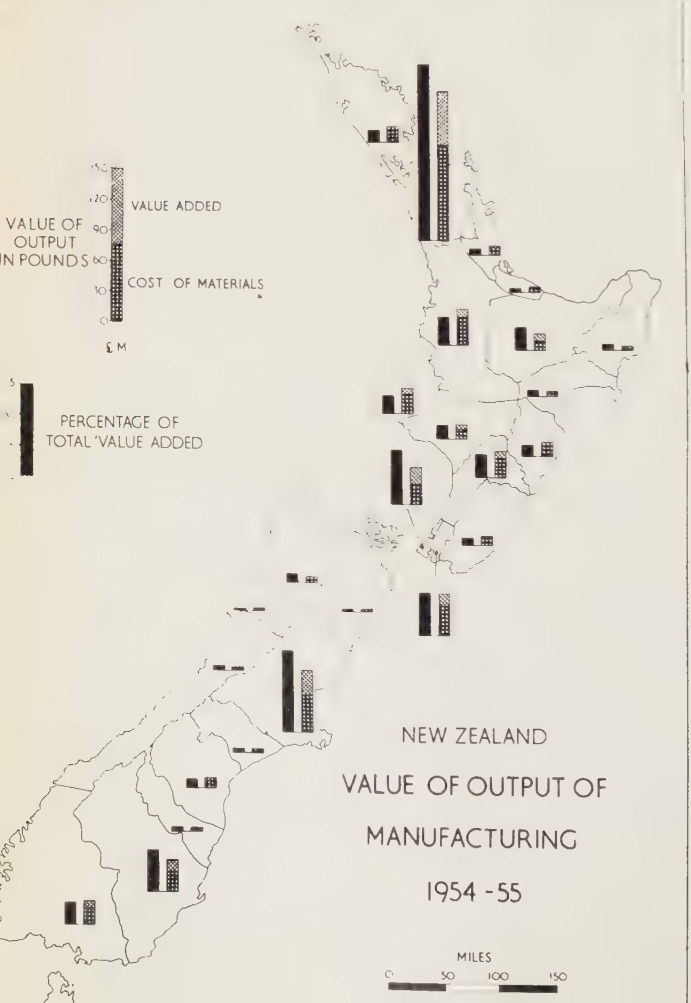
A recent trend, apparent also before the war, has been the location of the newer and more truly manufacturing industries in the four main centres. The dependence of a wide range of industry on imported raw materials emphasised the importance of a location near the overseas ports, which are also the areas in which the rate of population increase has been the greatest. The growing interdependence of industries on

Fig. 2.
Distribution of factories in New Zealand according to size-groups and by employment districts, 1956.



one another for materials and components has caused a tendency amongst the newer industries towards concentration rather than dispersal. At the same time, within the main centres, there has been a move away from the congested inner city areas with cramped facilities to new factory areas in the outer suburbs. Factories have often been built in pleasantly laid out surroundings. Penrose and Mount Wellington have developed in this way in Auckland; Riccarton, Hornby and Sockburn in Christchurch; and Ngahauranga, Taita and Upper Hutt have developed along with Petone and Lower Hutt in the Wellington area. Of the four main centres, only in Dunedin has there been little development of this nature. The new industrial areas developed with the erection of new factories employing semi-mass production methods and requiring large areas of flat land for an efficient lay-out. Floors, laid out on one level, enable fork-lift trucks and other mechanical handling devices to be used, with a marked increase in efficiency. The value of land in the centre of the cities has become so great that it no longer remains economic to use it for manufacturing. Transport difficulties, both for the collection and delivery of goods as well as for the parking of cars, are further reasons for moving away from the old, narrow, inadequate city streets.

After the war there was an acute shortage of female labour, more especially in the main centres. Whilst there was a general move of manufacturing to these centres, at the same time there was a movement of some industries to smaller towns where female staff was available. Industries such as tobacco manufacture, clothing and footwear, which employ a high proportion of female staff, were affected by this trend. Apart from the availability of labour, the use of the small electric motor (and the consequent mobility of industry) greatly facilitated such a



VALUE OF OUTPUT IN POUNDS
150
120
90
60
30
0
£M
VALUE ADDED
COST OF MATERIALS
5
PERCENTAGE OF TOTAL 'VALUE ADDED
NEW ZEALAND
VALUE OF OUTPUT OF MANUFACTURING
1954 -55
MILES
0
50
100
150

Fig. 3.
Value of factory output and percentage of total value added by employment districts, 1956.

movement. To some extent in the last year or two this trend has been reversed, for the need to reduce operating costs has caused manufacturers to close down scattered branch factories wherever possible, and to achieve economies of production—especially in management and maintenance—by concentrating operations under one roof.

In 1947 it was decided that the state should acquire, develop and lease land for industrial purposes, and to make surplus war stores available for industry. The Industrial Areas Committee was formed to undertake this work. Surplus stores were leased at Tamaki and Gracefield, and were used by cardboard box, motor body building, corrugated board, chemical and engineering industries. Land made available to industry included 80 acres of reclaimed land at Seaview, 70 acres at Taita, and an area at Naenae, all in the Hutt Valley, whilst others included some land at Porirua, and smaller areas at Palmerston North and at Penrose.[9]

Value Added by Manufacturing

Figures have recently been made available[10] showing the value added by manufacturing establishments in each of the twenty-five employment districts, and these are illustrated in Figure 3. The value of output is made up of two components—the cost of materials bought for manufacture, and the value added to such materials during the consequent processing. Data about the value added are among the most commonly used criteria for determining the importance of manufacturing, and they may be used either to compare the output of various industries or of various areas. The predominance of the four main districts, together with Lower Hutt, is again emphasised, for they contribute two-thirds of all value added in manufacturing. A large proportion of the remaining third is contributed by factories in the Hamilton, Palmerston North, Rotorua and Invercargill districts. The total value of production in 1954-1955 was £551 million, as against £129 million in 1939-1940, and £17 million in 1900-1901.[11] If allowance is made for changes in the value of money during this period, it appears that the volume of production is increasing at a steady annual rate of four and a half percent. If this rate of increase continues the total value of production in 1975 will be about £1,325 million—more than double the present total.[12]

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[9] J. K. Bewley: 'Changes in the Pattern of Industrial Production in New Zealand from 1938 to 1954'. *Proceedings of First Geography Conference*, N.Z. Geographical Society, Auckland, 1955, p. 48.

[10] Special supplement, *Monthly Abstract of Statistics*, July 1956.

[11] N. E. Dalmer: 'Industry: Its Development and Importance in New Zealand', *New Zealand: Inventory and Prospect*, Wellington Branch, N.Z. Geographical Society, Wellington, 1956, p. 68.

THE OUTLOOK FOR MANUFACTURING

During the last twenty years there has been a marked increase in the range and scope of manufacturing in the dominion. The volume of factory production has increased at a higher rate than the growth of population, this being due not only to the higher proportion of persons now employed in manufacturing, but also to changes in the methods used by factories. The economy of New Zealand is by no means isolated from the movement throughout the world towards freer trade; it is necessary, therefore, for goods manufactured in the dominion to be produced as cheaply as possible in order to meet competition from overseas imports, and to make semi-mass production methods worth while. Credit restrictions, competition from imports and keener competition between local firms have resulted in an improvement in methods, efficiency, and the production of a better quality of goods. In this way the resistance of other interests and of domestic consumers to locally made goods may be overcome.

Although the products of primary industries will remain the main source of wealth for New Zealand, it may be possible for certain manufactured goods—those in which the country has special advantages—to be exported and earn overseas exchange. The export of newsprint, for example, has already commenced. Estimates show that by 1975 the total population will be about three millions. There is a limit to the rate of expansion of primary industry, and it is probable that only a proportionate number of persons will be employed in the tertiary—or servicing—industries, so that it seems that about 130,000 persons will have to be absorbed by manufacturing in the next twenty years. A general tariff inquiry is being conducted, and on its report and subsequent policy decisions will depend the future growth of manufacturing in New Zealand, the part that it will play in the economy of the future, and whether it will be capable of absorbing its share of the population increase.

THE 'LOCATION FACTOR'

It is not sufficient to describe the distribution of manufacturing activities between the employment districts by percentages of dominion industrial employees alone. The use of unweighted figures tends to emphasise the importance of the Auckland, Christchurch, Wellington, Dunedin and Lower Hutt districts. More valuable are distributions weighted according to the total number of persons engaged in all activities within each district, which indicate whether manufacturing has more—or less—than its proportionate share of all workers.

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[12] N. E. Dalmer: *ibid*, p. 37.

For this purpose the 'location factor'[13] has been calculated for thirty-six groups of manufacturing in the twenty-five employment districts. This measure compares the proportion of all workers in each district with the proportion of those in particular industries. The proportion of the total labour force (except the armed services) in each district is the standard or 'norm'. Each industry has a distribution which varies from this norm and the location factor measures the extent of such variations for each district. It is calculated by dividing the percentage of all workers in a particular industry in a district by the percentage of all workers in that district.[14] Thus, each district in which an industry has a factor of more than 1 has more than its proportional or normal share of those workers; similarly, a factor less than 1 indicates a less than normal share.

The location factors have been plotted graphically in Figures 4, 5 and 6. On the graphs the width of each district has been drawn proportional to its share of the total labour force—so that the norm for each district is 1, and is indicated by a horizontal line across each graph. In this way the distribution of each industry is clearly apparent, for the column in a district in which an industry is more than normally concentrated rises above this line.[15] Graphs have been drawn for nine main groups of employment covering the total labour force (with the exception of the armed services). One of these, the graph of 'all employees in manufacturing', has been further analysed to indicate the distribution of twenty-eight individual industries. In addition, the distributions of 'all female workers' and 'female workers in manufacturing' have been included.

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[13] This measure was proposed by P. Sargant Florence in *The Statistical Method in Economics and Political Science*, London 1929, pp. 327–328, and *Economic Journal*, December 1937, pp. 622–623. The method is used and further discussed in *The Location of Industry*, P.E.P. Report, London, 1939.

[14] The calculation is quite simple. The percentage of the total working population in the Auckland district is about 22. In Auckland there is a higher proportion of all clothing workers—about 40—so that industry has a location factor of 1.80, indicating a high concentration. On the other hand, there are about 22 percent of workers in the bread-baking industry in the district, so that the location factor is 1.0, which indicates that Auckland has about its proportionate share of these workers. In fact the graph of the bread-baking industry in Figure 5 illustrates the effect obtained if the workers in an industry are dispersed more or less accordingly to all workers. The graph of an industry distributed amongst districts exactly in proportion to the distribution of all workers would have all the area below unity completely covered. In each graph if some districts have columns rising above unity, there must be in other districts an exactly similar area uncovered (below unity). For each district the area obtained by multiplying the height of the column by its width represents the actual number of workers.

[15] Care has to be taken in the interpretation of the graphs. It must be recognised that the employment districts of the Department of Labour and Employment may not be completely adequate for circumscribing and separating concentrations of manufacturing, although on the whole they probably give a fairly accurate picture. Furthermore, as the districts and the numbers of persons employed in a district vary greatly in size, districts like Greymouth or Westport (with a small percentage of the total labour force) may give undue emphasis to even a small concentration of a certain industry in that district. The number of persons represented by each graph must also be considered. For example, the graph of 'general engineering' represents 20,765 workers, that of 'grain milling' only 779.

Location of Industries

The weighted distributions shown in Figures 4, 5 and 6 clearly indicate the differences between the location of such industries as engineering, furniture and cabinet making, beverage manufacture and bread baking which show a more or less even distribution in relation to the total labour force, and others such as woollens, grain milling, and motor vehicle assembly which show marked concentration in a few districts.

The first group of industries[16] are those which may be termed ubiquitous, for they are distributed more or less proportionately in each district. The bread-baking industry most nearly approaches an even distribution, and this is a reflection of the relatively low value of the product, its perishability and consequent need for numerous small bakeries widely dispersed. Although employed in all districts, workers engaged in the printing and publishing trade are concentrated particularly at the main centres. A large amount of work undertaken by printers is for commercial or government offices which themselves tend to be concentrated in these centres, especially in Wellington. Such concentrations are also emphasised by the production of widely-circulating daily newspapers and trade, political and religious periodicals in the main centres. The four centres have concentrations of workers engaged in clothing manufacture, such industries being established where supplies of female labour are more abundant and where the largest markets are available. General engineering, which includes all types of engineering activities except motor vehicle assembly and shipbuilding, shows an even distribution, although Auckland, Lower Hutt, Christchurch, and Dunedin all have more than their proportionate share. The wide dispersal of the beverage industry, which includes breweries as well as soft drink manufacturers, reflects the advantages of a bulk-adding industry being located near the market.[17]

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[16] In the second column of Figure 4.

[17] Whilst Christchurch and Dunedin show marked concentrations, in Oamaru, within a 'dry district', there are no factories in this industry.

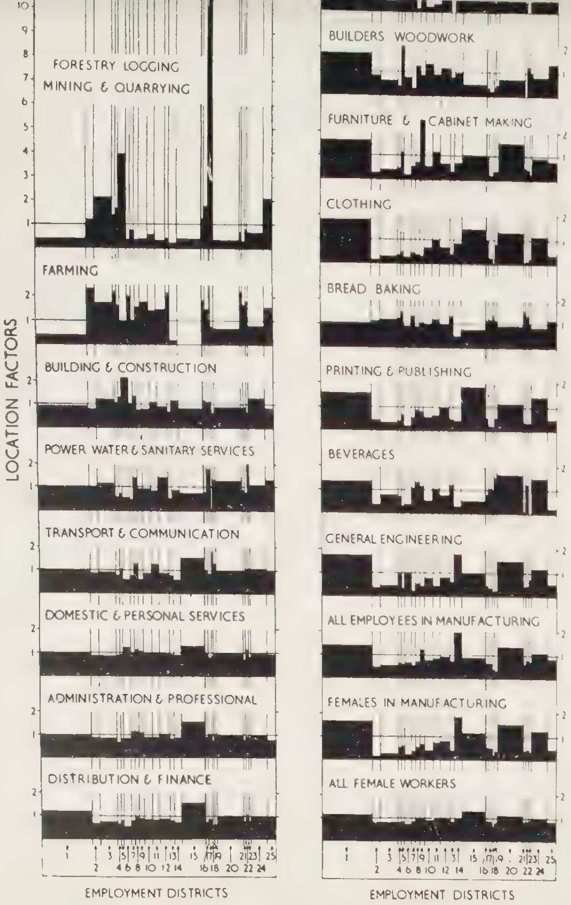

Fig. 4

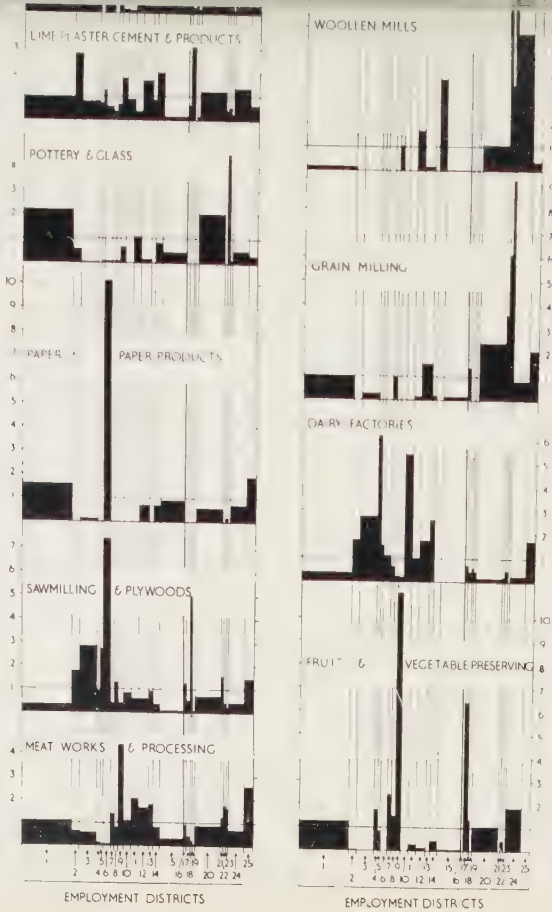

Fig. 5

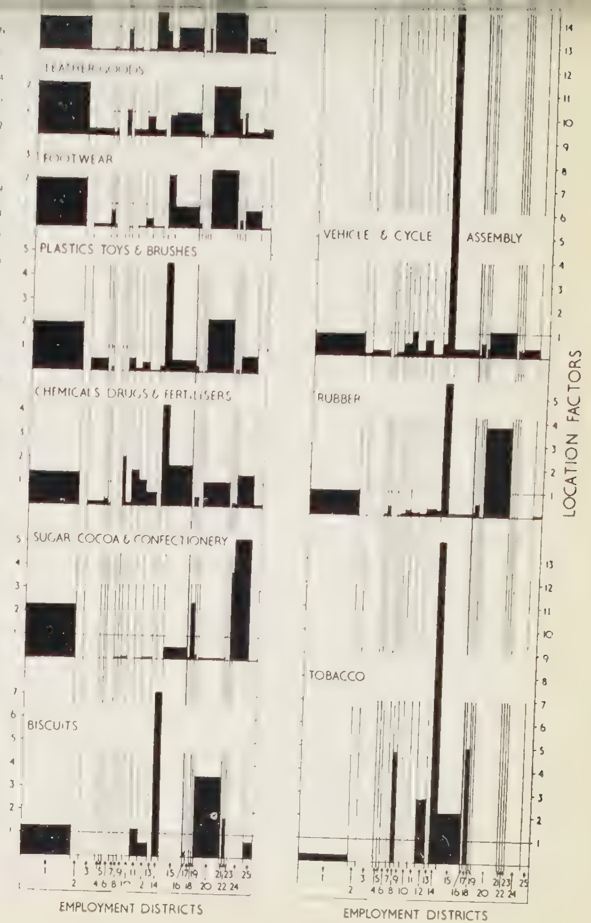

Fig. 6

N.Z. GEOGRAPHER

Figs. 4, 5 and 6. The 'location factor' of individual industries and of other categories of employment, 1956. (The width of the columns in each diagram indicates the proportionate share of the total labour force found in each district. The districts themselves are defined cartographically in Figures 1, 2 and 3, and are identified by name and number in the legend to Figure 1. The height of each column indicates the degree of concentration of each

Another group of industries which process primary products, including meat freezing works, dairy factories, and fruit and vegetable preserving plants, is located within easy reach of supplies. Meat works are distributed throughout the country but Invercargill and Hastings districts show particular concentrations of this industry. The importance of dairy factories in the Hamilton, Paeroa and New Plymouth districts, and of fruit and vegetable preserving in the Hastings and Nelson districts, is clearly indicated. This latter industry is concentrated in the fruit-growing areas so that the product can be processed as quickly as possible and damage by long freight hauls avoided. Grain milling is predominantly a South Island industry, with the Christchurch, Ashburton, Timaru and Oamaru districts having more than their proportionate share of employees. The paper and board making plants at Kawerau, Kinleith and Whakatane are concentrated in the Rotorua area, which also has a marked dominance of sawmilling.

There are several industries which use partly processed local materials as well as imported components, and the distribution of these 'true' manufacturing industries emphasises a port location. Rubber manufacture and vehicle assembly are concentrated in Lower Hutt, Auckland, and Christchurch.[18] Tobacco manufacturing and biscuit baking are also very concentrated, reflecting the few large modern plants established in the largest market centres.

Regional Characteristics

It is possible to use the location factors to indicate the broad character of manufacturing in each employment district. It can be seen that Lower Hutt has the highest concentration of manufacturing[19] when compared with the total working population with a factor 1.94. Other high concentrations are shown in Auckland, Christchurch, Hastings and Dunedin. All other districts have less than their proportionate share of employees in manufacturing, but amongst these—apart from Greymouth and Westport—manufacturing is fairly evenly distributed. Hastings district has the fourth highest concentration of workers in manufacturing, whereas Wellington has fewer than the number which might be expected from its share of the total working population. If the graph of the distribution of 'all female workers' is compared with that of 'females in manufacturing', Lower Hutt is again predominant, followed by Auckland, Christchurch, Dunedin and Wellington districts, whilst in all other districts there are fewer than the proportionate numbers of female employees.

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[18] These three districts employ 88 percent of the employees in vehicle assembly, and 90 percent of those in rubber manufacture.

[19] See Figure 4 graph of 'all employees in manufacturing'.

While it is not possible to compare the location factors of all industries in a district, it is possible to summarise the number of industries in each district which show various degrees of concentration. The differing sizes of the districts and the generalised nature of the groups of industry preclude any exact classification, but the method allows comparison of the main characteristics of the districts. In the Lower Hutt district there are eleven industries which show marked concentrations,[20] whilst in Christchurch there are concentrations of nine.[21] Most employment districts have at least one industry showing a significant concentration. As would be expected, Greymouth and Westport have a narrow range of industry, the former having little or no employment in twenty-one groups of industry, and the latter in twenty groups. On the other hand, the Lower Hutt, Auckland, Palmerston North, Christchurch and Dunedin districts all have at least twenty-one industries in which they have a proportionate, or more than proportionate, share of employment. Within these districts, employment in manufacturing is widely based.

SUMMARY

It is well known that the four main districts, Auckland, Wellington, Christchurch and Dunedin, together with Lower Hutt, employ a high proportion of the workers engaged in manufacturing activities. The use of unweighted percentages shows that Auckland has more than half the number of persons employed in these districts, and one-third of all the workers. This, however, is not surprising for Auckland is the largest centre of population. On the other hand, the use of weighted quotients shows that Lower Hutt is, for its size of working population, a highly concentrated industrial area, with fifty percent of all persons working in the district employed in manufacturing.[22] The same method also introduces the Hastings district as one of the five in which manufacturing has more than its proportionate share of all employees, whereas Wellington has fewer workers in industry than might otherwise be expected. On the other hand it has a larger proportion than elsewhere of persons engaged in commercial and administrative activities. The use of location factors enables objective comparisons to be made be-between the various districts, and these in turn could be used in planning future development. The method is not specific enough to allow precise statements to be made about future development, because the groups of industry used are broad and administrative districts are necessarily adopted to describe industrial areas. Its tentative use here, however, serves to indicate the direction along which further research is necessary to explain the present patterns of location more precisely and to forecast future and desirable trends in industrial localisation in New Zealand.

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[20] These are chemicals; rubber; plastics, toys and sports goods; motor assembly; footwear; biscuits; tobacco; woollens; leather goods; other textiles including felt; case, crate and barrel making.

[21] They are footwear; knitwear; leather goods; grain milling; biscuits; rubber; plastics, toys and sports goods; pottery and glass; and other textiles, including carpets.

[22] The proportions in the four main centres are: Auckland 34.0; Christchurch 32.0; Dunedin 25.0; Wellington 21.0; whilst that for Hastings is 25.0.

THE OUTLYING ISLANDS OF NORTHLAND

G. R. COCHRANE

THE ISLANDS located off the northeastern coast of the North Island of New Zealand are extremely scattered and vary widely in geographic character. Major contrasts in location, size, shape, elevation, local relief, landforms and geological structure, in inherent fertility and vegetal and faunal communities, and in the extent of cultural modification all manifest themselves in varying degrees and contribute to the heterogeneity of the islands.

These 140 islands with their associated skerries, stacks, rocks and reefs cover approximately 95,600 acres scattered over more than 1,000 square miles of ocean (*Fig.* 1). The north-south distance from the Three Kings to the Slipper Group is over two hundred and forty-three miles, whilst the west-east distance from the Three Kings to the Alderman Islands is two hundred and six miles. Although only the Three Kings Group is more than thirty-five miles from the nearest point on the mainland, and although some fifty-eight islands lie within ten miles of its shores, isolation is a characteristic feature. Ease of access varies considerably, but, in general, transportation and communication links with the adjacent mainland are poor, a notable exception being Urapukapuka in the Bay of Islands Group. Actual distances from the mainland are not very great. In fact, from most of the islands some part of the mainland can be seen on clear days when visibility is good.

ISOLATED BY ROUGH SEAS

The state of the sea is however a better measure of the isolation of these islands. On many occasions seas are extremely treacherous and cause shipping movements to be postponed. This is borne out by the fact that between 1795 and the present day fifty shipwrecks have occurred on these islands and have resulted in a substantial loss of shipping tonnage and in a heavy loss of human lives.[1] In several instances people on the mainland were not aware of these disasters. Generally most of the islands offer no shelter from storms because of the numerous sunken rocks, treacherous reefs, swift currents and tidal sets, whilst inhospitable cliffs and frequent heavy surf make landing a dangerous task. Thus many of the outlying islands of Northland are seldom visited, even by fishermen.

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[1] Two of the most disastrous wrecks were the complete loss of the *Wairarapa* on 28 October 1894, when 121 lives were lost, only 82 bodies ever being recovered; and the total loss of the *Wiltshire* on 31 April 1922. The 103 officers and men of the latter vessel were saved after rescue attempts which extended over forty-eight hours.

Distance by sea from mainland ports emphasises this isolation. Only fifteen islands are within ten miles of any mainland port or harbour.[2] None of the truly outlying islands is within thirty miles of a major port. On Great Barrier Island the ports of Tryphena, Okupu, Whangaparapara and Port Fitzroy are between fifty-five and fifty-eight miles from Auckland, and are more than sixty miles from Whangarei. The Three Kings Group is over seventy miles from the nearest port, Houhora, whilst Whangarei and Auckland are 186 and 264 miles distant respectively. The four largest islands—Aotea or Great Barrier Island, Hauturu or Little Barrier Island, Kawau, and Ahuahu or Great Mercury Island—together account for 87.54 percent of the total land area of the outlying islands. They are all more than forty miles by sea from Auckland, Kawau excepted. It lies twenty-seven miles to the north of Auckland.

Size and Shape of the Islands

The sizes of the various islands range from the 67,500 acres of Aotea, the 6,960 acres of Hauturu, the 5,200 acres of Kawau and the 3,800 acres of Ahuahu through many intermediate sizes to small islands of under ten acres. Shapes owe much to geological structure and to the degree of exposure to active erosional agents, varying from the roughly circular Hauturu and Motueka through a wide variety of irregular outlines to the east-west attenuated Taranga or Hen Island and to the elongated, irregular, deeply-indented Aotea. Where soft rocks adjoin resistant rocks, and both are subjected to active and vigorous marine erosion, a highly irregular shape is produced. The softer rocks are cut back and the more resistant remain as points or bluffs. Irregularities in shape are also produced when an island has a markedly exposed seaward coastline and a relatively sheltered landward shoreline. The northern cliffs of Motu Arohia in the Bay of Islands Group are exposed to the full fury of ocean gales and have been cut back steeply, with numerous offlying rocks, reefs and shelves. The sheltered southern coast has low cliffs and sweeping sandy beaches. Similar features are characteristic of Ahuahu, Whakahau or Slipper Island, Motukawanui in the Cavalli Islands and Urapukapuka. Progradation of the shoreline also contributes to irregularities in island shape. Notable examples are the triangular-shaped boulder spit areas of Te Titoki and Hingaia on Hauturu, and a much smaller area at an eastern point of the central island of the Aldermans.

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[2] These are the ports of Auckland and Whangarei; the minor ports of Houhora, Mangonui, Whangaroa, Russell and Opua, Whitianga and Tairua; and the harbours of Tutukaka, Leigh and Whangamata.

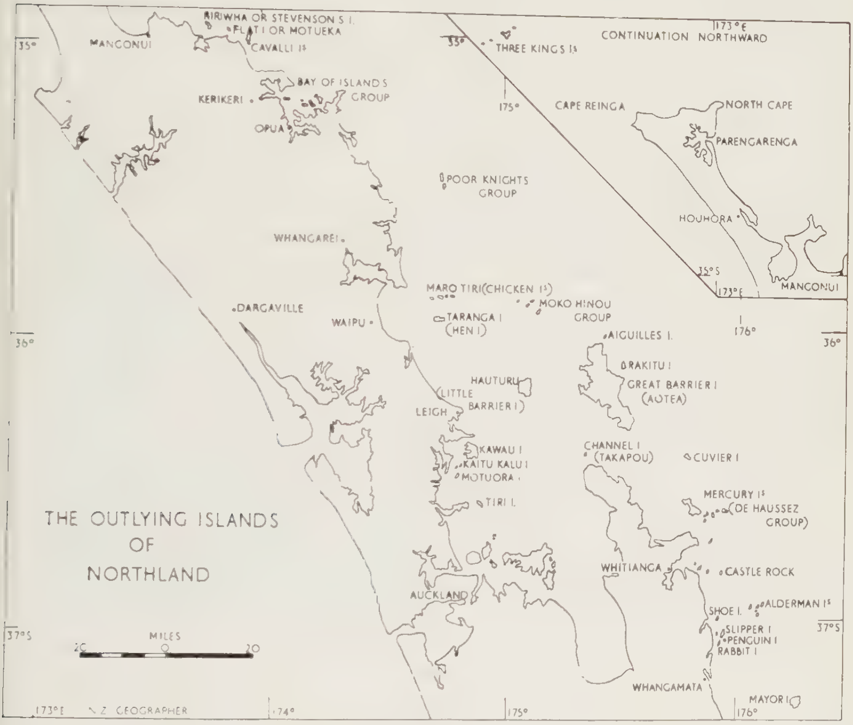

Fig. 1. The outlying islands of Northland.

A great variety of elevation and local relief adds to the characteristic diversity of the outlying islands of Northland On Aotea and Hauturu are found the greatest elevations and the greatest range in local relief.[3] At Kaitoke on Aotea and at Te Titoki on Hauturu extend areas of almost level land having little or no relative relief. Elevations are below twenty feet.[4] Yet within three-quarters of a mile of the Kaitoke lowland area, and within half a mile of Te Titoki, areas of high, dissected, mountainous country rise steeply with deep ravines, jagged pinnacles and numerous tortuous valleys where local relief almost equals the elevation. Here the greatest elevations are between 1,500 and 2,300 feet, and local relief ranges from 1,350 to 2,000 feet. Many of the medium-sized islands have an elevation of approximately between 400 and 700 feet, with moderately steep slopes, while a large number of the smaller islands rise from sea level, or from abrupt cliffs, to rounded domes. This profile is characteristic of the majority of the smaller islands. Many islets, usually under five acres in extent, are characterised by a low elevation and in consequence they are spray-lashed and frequently swept by waves during storms. Whale Island and Little Ohena Island in the Iles d'Haussez (the Mercury Group) are typical examples.

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[3] The highest peaks are: on Aotea, Hirikamata or Mt. Hobson, 2,038 feet; on Hauturu, Hauturu or Mt. Archeria, 2,370 feet.

[4] The Kaitoke swamp, 600 acres in extent, has so little fall to the sea that it is not practicable to drain it.

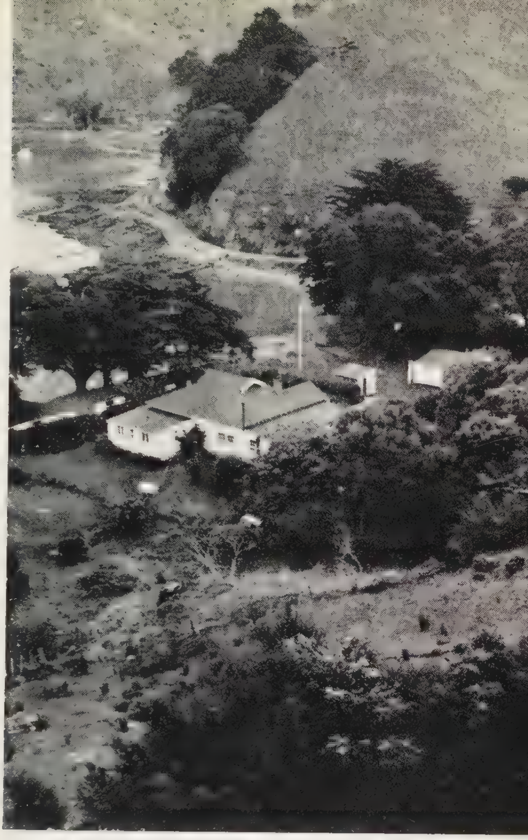
Photo: N.Z. Herald

Fig. 2. The stock-scow *Rahiri* loading cattle at Puriri Bay, Tryphena Harbour, Aotea.

Apart from two shallow depressions, Motueka, eighty-nine acres in extent and 110 feet high, aptly reflects its European name of Flat Island. Located six miles east of the Whangaroa Heads, this island contrasts markedly with Taranga, a high-peaked island with a very large relative relief. Both islands differ considerably from those in the Bay of Islands Group or from Kawau, and similar wide contrasts in elevation and local relief occur throughout the outlying islands.

Within particular island groups contrast and diversity are characteristic, while even within a single island it is quite common for wide and very distinctive variations to occur. Frequently the degree of cultural

Fig. 3. Settlement at Okupu, Aotea, typical of many on the outlying islands of Northland. The farmstead, the tiny post office on the lawn near the flagpole, the narrow road to the wharf, the launch, the poor pasture, the pohutukawas and the macrocarpas —these are integral features of an island landscape in northern New Zealand.



modification to which these islands have been subjected contributes significantly to these differences. Rich variations in landscapes, frequently resulting directly or indirectly from man's economic activities, are especially noticeable on Aotea—as, for example, those consequent upon mining, timber felling, gum digging, firing, draining, pasture planting and afforestation.

SIGNIFICANCE OF TRANSPORT

Variety in cultural modification is often a reflection of transport problems, and regular transport facilities are often not available, or, at best, a poor weekly or fortnightly service is typical (*Fig.* 2).* Linked with these poor services are such features as the very sparse and scattered population, the generally low standard of farming, and the limited economic opportunities. The peripheral distribution of settlements—which are established usually on areas of small relief adjacent to fertile alluvial valley or bayhead flats on relatively sheltered coastlines—reflects both the limited areas of land suitable for farming and the dependence on sea communications (*Fig.* 3).

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*Editorial note. Regular services by scow have now ceased, despite the establishment of a whaling station on Aotea in 1956. Small aircraft, however, provide a link with this island.

Only eleven of the islands are permanently occupied. Of a total of 437 inhabitants, 275 are to be found on Aotea and 111 on Kawau.[5] A further nine islands account for only forty-one persons. Population has been relatively static in all the inhabited islands except Kawau and Aotea, where fluctuations have coincided with stages in the economic exploitation of the island resources. Over the last two decades Kawau has shown a steady increase in population, for many semi-retired and retired people have built cottages around the shores of the numerous inlets, especially around Bon Accord Harbour. Three families are stationed on Cuvier Island and on Burgess Island, the latter in the Moko Hinau Group, to service and maintain the lighthouses that guard the southern and northern entrances of the Hauraki Gulf. Eight other islands lying athwart the busy approaches to Auckland are equipped with light beacons visible at sea level from six to twenty miles away, but as they are unattended the islands carry no population.

Diversity of Landscapes

A very distinctive characteristic of the outlying islands of Northland is the considerable diversity of landscapes over a small compass. Within two miles of the mouth of Whangapoua estuary on Aotea, sweeping bays of gleaming white sand and sparsely-vegetated sand dunes contrast with boulder beaches, precipitous wave-lashed headlands, and bare eroded cliffs; light-green raupo swamps contrast with neatly-fenced bayhead flats and drained swamps under fresh-green sown pastures; the whole being set against the backcloth of brown danthonia-covered hills, drab grey-green expanses of manuka shrubland, jagged rhyolite peaks, dissected bush-clad hills, dark-green exotic pine plantations, and dun-coloured salt swamps and estuarine mudflats broken only by scattered clumps of mangroves. A similar variety of landscapes is found on all the larger islands and, in addition, there is diversification between the individual islands, as, for instance, between the danthonia-covered hills of Ririwha, off the Whangaroa Heads, and the densely bush-clad peak of Taranga, off the Whangarei Heads.

Generally speaking, the outlying islands enjoy a climate considerably milder than that to be found in comparable mainland locations. Frosts are unknown on all the smaller islands and are almost unknown on Aotea and Kawau. The ameliorating influence of large expanses of open sea allow many subtropical and some tropical shrubs and fruits to thrive in gardens protected from strong salt-laden winds. Prevailing winds differ quite markedly on the various islands, and precipitation also ranges from thirty-three to thirty-seven inches annually at Motukawanui in the north and Whakahau in the south to between fifty and sixty inches on Aotea, and over sixty inches on Hauturu. Rain days vary from 130 to 190 per annum.

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[5] See *Population Census 1951;* Vol. I, *Increase and Location of Population,* Wellington, 1953.

Since all islands experience broadly similar climatic conditions major differences in soils are to be attributed to variations in the parent materials and to differing degrees of slope. Throughout the islands soils are generally of poor fertility, being frequently acidic and generally leached. Important exceptions are the dark silt-loams of high fertility on Motueka, the brown clay-loams of Whakahau, and the organic soils of drained peat areas at Awana, Kaitoke and Oruawharo on Aotea. These differ considerably from the overall low fertility of the stiff leached yellow clays of the Cavalli and Mercury Islands. Similar poor soils cover sections of the western and southern dissected plateaus of Hauturu and extensive areas on the west and south of Aotea. A thin layer of poor soils composed of dry, partially-decomposed rhyolite boulders is typical of the Poor Knights, parts of the Moko Hinau Group, and of extensive areas within the central mountainous core of Aotea.

Cultural Modification

Without exception all the outlying islands have been visited or settled by man at some period. However, cultural modification of the indigenous vegetal and faunal communities varies enormously amongst the islands. The pre-European Maori was essentially a conservator of forest resources. His culture emphasised, by custom and the strict application of rules (*rahui* and *tapu*), the preservation of the forest and its bounties. The resources of nature were 'farmed', not exploited or destroyed as was later the case when European customs were introduced or adopted. It is this degree of cultural modification which, despite their wide range in size, their scattered distribution, and despite the overall extreme diversity, provides a basis of classification for the outlying islands of Northland. There are three broad classes.

The islands where cultural modification of the former vegetation has been significant are, in most instances, inhabited or farmed islands devoted largely to a form of extensive pastoralism. The production of wool is the single most important aspect of the economy, though rearing of store stock and of some prime stock (notably on Ahuahu), dairying, tourism, fishing, bee farming, and firewood cutting also occur. Mining and logging operations were both formerly of considerable importance but are unimportant today. Agricultural methods are usually ultra-conservative, as is indicated by the lack of mechanisation the land use and the general character of farming activities. Most of the farming landscapes on these islands also reflect the limited incentive for increased and improved production arising from the extremely infrequent and often hazardous transport services (*Fig.* 2). A characteristic feature of the farming methods and, incidentally, of seasonal changes in the aspect of the vegetation over wide areas, is the practice of the annual firing of danthonia (*Danthonia semiannularis*) pastures in an endeavour to combat weed invasion. In the long run this gives rise to exactly the opposite result and at best is but a transient answer to graziers' problems. Reverting pastures, low stock-carrying capacities, extensive encroachment of pastures by manuka (*Leptospermum scoparium*), and frequently fairly severe erosion are typical features throughout many of the dominantly-modified islands.

Considerable scope therefore exists for improved farming practices and for a vastly increased farm production on most of the inhabited islands. This has been proved over the last eight years on the three islands of Whakahau, Ahuahu and Motukawanui, but the overall incentive for a greater agricultural output is lacking. Introduced animals, both as stock and as pests, have frequently acted as very destructive modifying agents.[6] Presence or absence of these creatures is vividly reflected in vegetal communities, and contributes considerably to the individual distinctiveness of the islands.

ISLANDS OF LITTLE CULTURAL MODIFICATION

The partially-modified island groups and the predominantly unmodified island groups are interesting because of the transitions they show from significant human interference on many islands to its total absence on the Aldermans. (See Figure 4a.) Both these major classes are considerably smaller in area than those of the former class and are generally economically less attractive for farming or settlement. Resulting in part from these factors and in part from the fact that most of the islands of these second and third classes are very isolated and exposed, much of the vegetation remains in a near-natural state. In addition,

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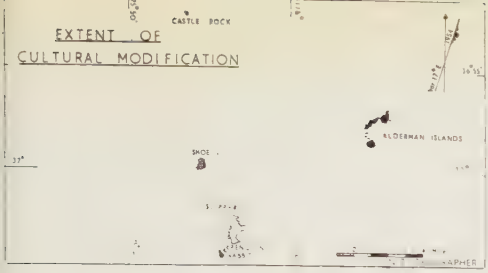
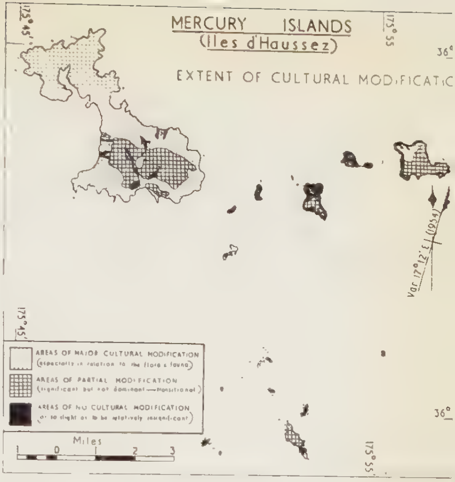
[6] All the following have now become pests on one or more of the outlying islands: deer, wild goats, wild pigs, wild cattle, rabbits, rats, mice, wild cats, opossums, wallabies and wallaroos.




MERCURY ISLANDS
(Iles d'Haussez)
EXTENT OF CULTURAL MODIFICATIC
175°45'
175°55'
36°
AREAS OF MAJOR CULTURAL MODIFICATION (especially in relation to the flora & fauna)
AREAS OF PARTIAL MODIFICATION (significant but not dominant—transitional)
AREAS OF NO CULTURAL MODIFICATION (or so slight as to be relatively insignificant)
Miles
1 0 1 2 3
Var 17° 32' E (1954)

Figs. 4a and 4b. Cultural modification of the indigenous vegetation in the Alderman, Slipper and Mercury groups of islands.

they are usually less accessible than the predominantly-modified islands, and, moreover, many of them are now protected sanctuaries.

The interaction of purely physical features is of considerably greater importance on the island sanctuaries than on the farmed islands, where there is a continual interaction between cultural and physical phenomena. The study of the vegetation of the island sanctuaries and of the smaller unmodified islands affords a strong contrast with the extensively modified plant communities on the great majority of the outlying islands. Broadly speaking, mere distance from the mainland has but little effect upon the limitations of man's modifying influences. Both Kawau and Great King Island of the Three Kings Group, respectively the closest and most distant islands from the mainland, have been extensively modified. It is generally true to say, however, that the larger island groups have experienced greater interference from cultural agencies than have the smaller groups. Also within any particular island group it is commonly the larger islands that have been most affected by man.

Accessibility, rather than distance from the mainland and mere area, also seems to govern the degree of cultural modification to which the islands have been subjected. In many instances, however, the larger islands offer greater possibilities for landing than do the smaller, but this is not always so. The Princes, the Three Kings and the Aldermans, all islands with inhospitable shorelines, are the least changed, but this is not so in the case of Cuvier and Burgess Islands where the lighthouses stand. There the vegetation has been substantially altered, despite the fact that landing is frequently difficult and often dangerous (*Fig.* 5).

Ruggedness of terrain is a secondary factor in the degree of cultural modification experienced within an area. Rugged areas within islands having reasonable access—for instance, large tracts of Aotea—have been utilised by man in preference to less rugged areas on islands where landings are hazardous, as, for example, the gently-sloping Hongiora in the Aldermans. Invariably, however, the easier slopes of the modified islands have been favoured by man and his animals, whereas the steepest portions have been avoided.

Where the two factors of inaccessibility and ruggedness are combined, as is the case with Hauturu, Tawhiti Rahi in the Poor Knights Group, Taranga, and the Alderman Islands, the impact of human and animal agencies has been but slight. In contradistinction to this, those islands with relatively easy access to the mainland and with moderately easy slopes, such as the Cavalli Islands, the Bay of Islands Group, Kawau and parts of Aotea, have experienced extensive cultural modification. (See Figures 4, 5 and 8.) There are exceptions to all these generalisations, but near-natural areas are generally located on the most inaccessible islands and on the smaller ones. Within a particular island the most broken mountainous areas are commonly the least modified. The high, rugged interior of Aotea and of Hauturu are cases in point.[7]

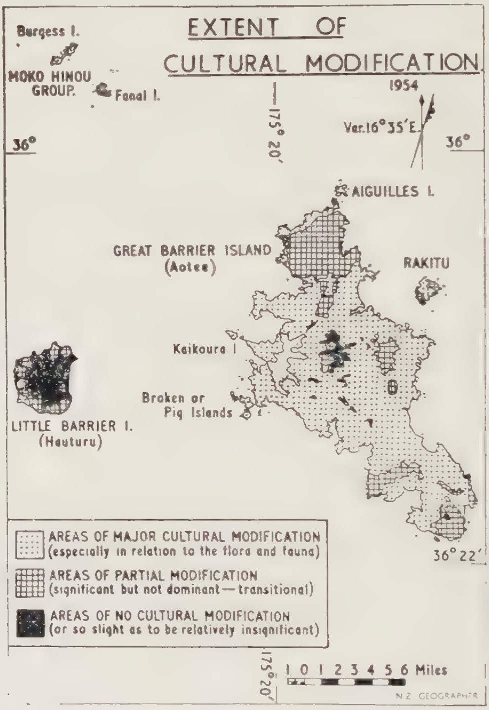

EXTENT OF CULTURAL MODIFICATION
1954
Burgess I.
MOKO HINOU GROUP.
Fanal I.
36°
175° 20'
Ver.16°35'E.
36°
AIGUILLES I.
GREAT BARRIER ISLAND (Aotea)
RAKITU
Kaikoura I
Broken or Pig Islands
LITTLE BARRIER I. (Hauturu)
AREAS OF MAJOR CULTURAL MODIFICATION (especially in relation to the flora and fauna)
AREAS OF PARTIAL MODIFICATION (significant but not dominant — transitional)
AREAS OF NO CULTURAL MODIFICATION (or so slight as to be relatively insignificant)
36°22'
175° 20'
1 0 1 2 3 4 5 6 Miles
N.Z. GEOGRAPHER

Fig. 5. Extent of cultural modification on Aotea, Hauturu and the Moko Hinau Group.

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[7] Following this general account it is intended to survey very briefly the majority of the dominantly-modified islands. This class embraces most of the islands and includes the greater number of the larger islands, and it is these which have experienced the greatest change. One island will then be discussed in more detail as broadly representative of this class.

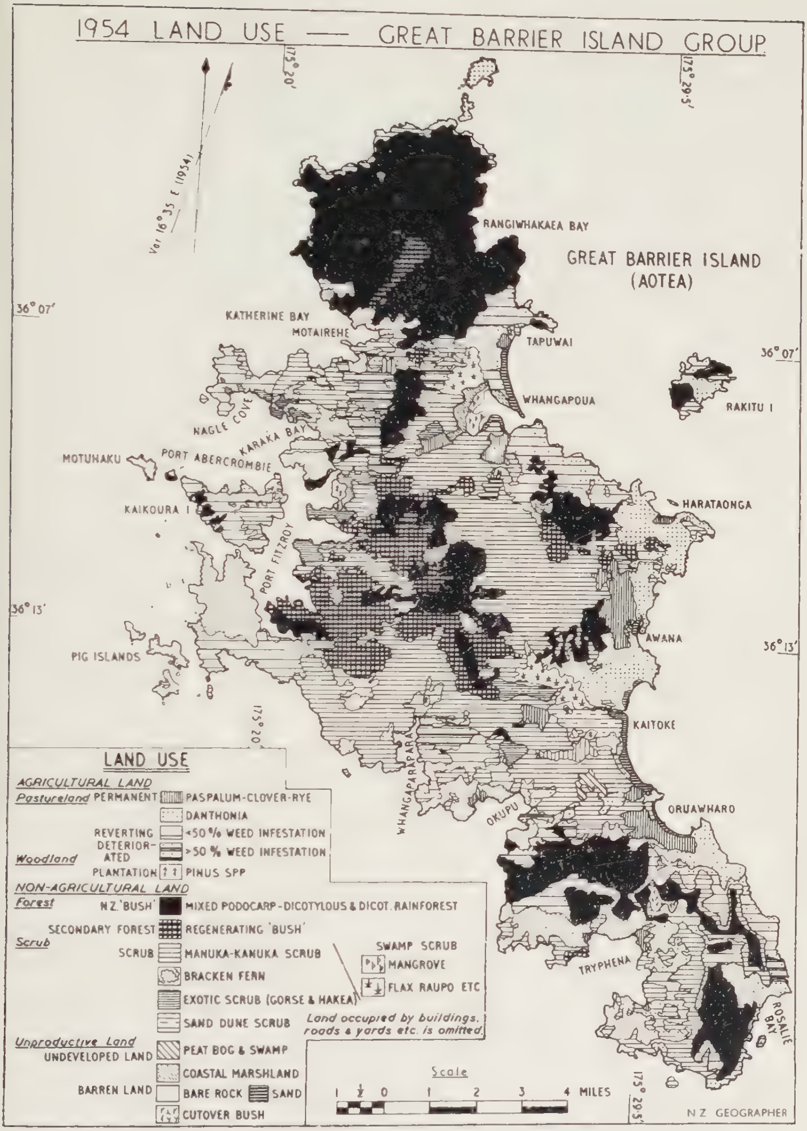
1954 LAND USE — GREAT BARRIER ISLAND GROUP
175° 20'
175° 29.5'
Var 16° 35' E (1954)
RANGIWHAKAEA BAY
GREAT BARRIER ISLAND (AOTEA)
36° 07'
KATHERINE BAY
MOTAIREHE
TAPUWAI
WHANGAPOUA
RAKITU I
NAGLE COVE
KARAKA BAY
MOTUHAKU
PORT ABERCROMBIE
KAIKOURA I
PORT FITZROY
HARATAONGA
36° 13'
AWANA
PIG ISLANDS
KAITOKE
WHANGAPARAPARA
OKUPU
ORUAWHARO
TRYPHENA
ROSALIE BAY
LAND USE
AGRICULTURAL LAND
Pastureland PERMANENT ▥ PASPALUM-CLOVER-RYE
DANTHONIA
REVERTING <50 % WEED INFESTATION
DETERIORATED >50 % WEED INFESTATION
Woodland PLANTATION PINUS SPP
NON-AGRICULTURAL LAND
Forest N.Z. 'BUSH' ■ MIXED PODOCARP-DICOTYLOUS & DICOT. RAINFOREST
SECONDARY FOREST REGENERATING 'BUSH'
Scrub SCRUB MANUKA-KANUKA SCRUB
BRACKEN FERN
EXOTIC SCRUB (GORSE & HAKEA)
SAND DUNE SCRUB
SWAMP SCRUB
MANGROVE
FLAX RAUPO ETC
Land occupied by buildings, roads & yards etc. is omitted
Unproductive Land
UNDEVELOPED LAND ▧ PEAT BOG & SWAMP
COASTAL MARSHLAND
BARREN LAND □ BARE ROCK ▤ SAND
CUTOVER BUSH
Scale
1 ½ 0 1 2 3 4 MILES
N Z GEOGRAPHER

Fig. 6. Land use on the Great Barrier Island Group, 1954. (For basis of land-use classification see J. W. Fox: 'Land-Use Survey', *Auck. Univ. Coll. Bull. No. 49, Geography Series No.1, 1956.)*

By far the largest of the dominantly-modified islands is the Great Barrier Island Group which covers 70,400 acres—an area which accounts for almost three-quarters of the total land area of the outlying islands of Northland. In addition to its significant size, this group is characterised by its dominantly rugged nature, by its widely-varying landscapes, by its history of mineral exploitation, and by the ruthless

Photo: N.Z. Herald

Fig. 7. The remains of an old kauri dam in the upper reaches of the Kairara Stream, Aotea.

destruction of its former magnificent kauri (*Agathis australis*) forests. Poor farming techniques, severe erosion, persistent weed infestation and critical transport problems contribute to the general backwardness of this island group. Cultural modification has been very marked and widespread. (Compare Figures 5 and 6.)

Like the Great Barrier Island Group, several smaller island groups have experienced major cultural modification over the last eighty years or so, namely, the Cavalli Islands, the Bay of Islands Group, the Kawau Group, Ahuahu, and the Slipper Group. All the larger islands of these groups are utilised for farming—chiefly for sheep with an emphasis on wool production. Farming practices are usually not very enlightened and this is generally reflected in the present land use. Isolation and acute transport problems also contribute to the type of farming which is practised. Small homesteads and work by family labour are common on the permanently-settled islands. On the uninhabited islands which are farmed, the stock are visited only when seasonal work such as shearing, crutching and dipping is necessary, or when stock are mustered for culling and removal. Seasonal tourist traffic, especially yachts and pleasure boats, in some of the more attractive bays is of considerable importance on three of the islands—Moturoa and Urapukapuka in the Bay of Islands Group, and Kawau. The larger assemblage of buildings, the crowds of holidaymakers, and the bright lights and gaiety at night contrast markedly with the small homesteads and the quiet, unhurried atmosphere associated with the island farmers. The seasonal change at certain bays on those islands which cater for tourists is very distinctive.

The Cavalli Islands have experienced considerable changes at the hands of man. Only the steep, twelve-acre Motuharakia and several rocky stacks have escaped cultural modification of their vegetation. Motuharakia is still covered in dense coastal scrub, and the other stacks, sparsely covered with cliff species, cannot be climbed without difficulty. The remaining islands of the Cavalli Group, as well as Motueka and Ririwha (*Fig.* 8), have had an earlier coastal scrub and coastal forest community replaced by other vegetation. In most instances, especially on the steep 400-foot hill slopes of the larger islands, indigenously-induced danthonia-dominant grassland communities are now the major plant covering. All these larger islands, which range from 89 to 760 acres, have at least one permanent spring or stream—a feature which is not common. Remnants of coastal forest remain in some of the steeper valleys on Motukawanui.

Similarly, in the Bay of Islands Group the five large eastern islands[8] were once covered by a coastal scrub and coastal forest vegetation which has now been replaced almost exclusively by danthonia, an exception being the 128-acre Motu Arohia. Here, over the last fourteen years, some ninety acres have been planted to exotic pines (*Pinus radiata* and *P. silvestris*). The dark green of this vegetation contrasts vividly with the prevailing light brown of the adjacent danthonia-covered islands with their rolling to steep terrain. Well over half of Moturoa is covered with an induced manuka scrub two to seven feet high (*Fig.* 9).

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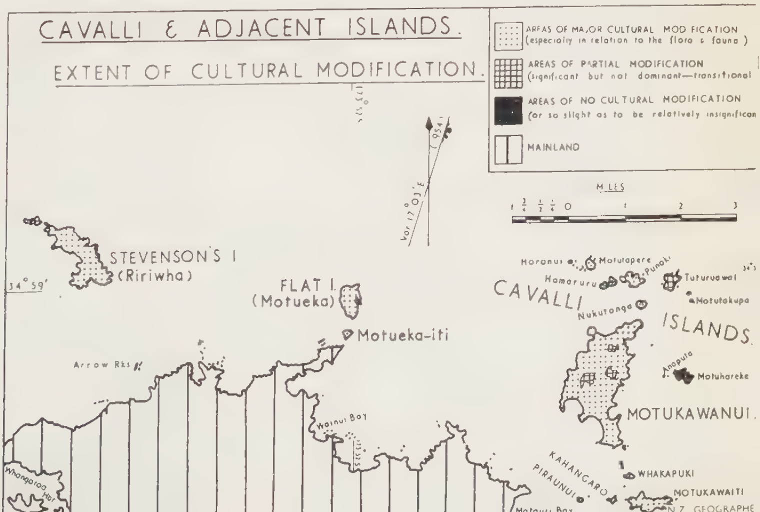
[8] Urapukapuka 510 acres, Moturoa 374 acres, Waewaetorea 115 acres, Motukiakia 67 acres and Okahu 53 acres.

Fig. 8. Cultural modification on the Cavalli and adjacent islands.



As was the case with the four larger islands of the previous group, the larger islands in this group are devoted to the grazing of Romney sheep or Hereford beef cattle.

Kawau, 5,200 acres in area, has been given over less exclusively to farming than the island groups described above. Yet it has experienced a very destructive cultural modification. A complete and ruthless destruction of the coastal and mixed forest species which formerly covered most of the island has taken place. Fire and the depredations of wallabies, wallaroos, opossums, deer and farm stock have taken their toll. A poor manuka community covering more than 3,500 acres appears to be a culturally-induced climax vegetation. Smaller areas of danthonia pasture and patches of exotic paspalum (*Paspalum dilatatum*) pastures, contrast with the drab grey-green monotonous expanses which cover the rolling hills of Kawau (*Fig.* 10). Around Mansion House Bay, tall eighty-year-old pines and several acres of self-sown pines form effective windbreaks and present a refreshing change of colour. This bay is a favourite haunt of Auckland pleasure craft and is the site of the hotel which was once the home of Sir George Grey, a former Governor of New Zealand.

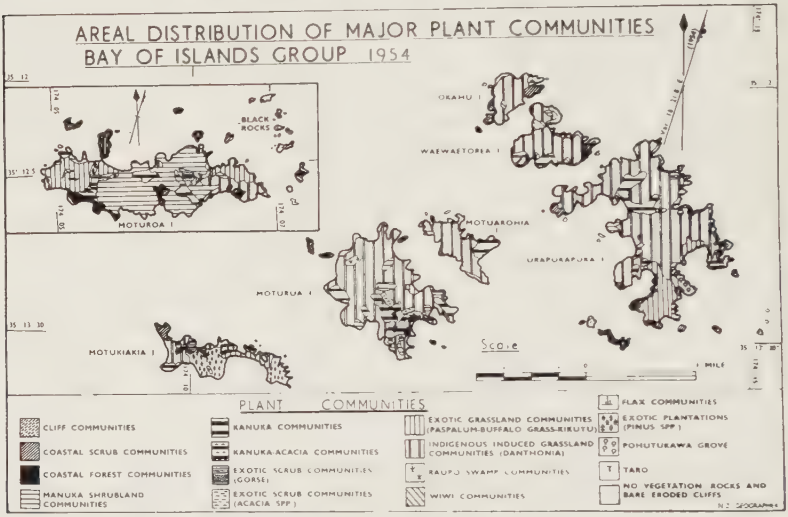

AREAL DISTRIBUTION OF MAJOR PLANT COMMUNITIES
BAY OF ISLANDS GROUP 1954
BLACK ROCKS
MOTUROA I
OKAHU I
WAEWAETOREA I
MOTUAROHIA
URAPUKAPUKA I
MOTURUA I
MOTUKIAKIA I
Scale
0
1 MILE
PLANT COMMUNITIES
CLIFF COMMUNITIES
COASTAL SCRUB COMMUNITIES
COASTAL FOREST COMMUNITIES
MANUKA SHRUBLAND COMMUNITIES
KANUKA COMMUNITIES
KANUKA-ACACIA COMMUNITIES
EXOTIC SCRUB COMMUNITIES (GORSE)
EXOTIC SCRUB COMMUNITIES (ACACIA SPP.)
EXOTIC GRASSLAND COMMUNITIES (PASPALUM-BUFFALO GRASS-KIKUYU)
INDIGENOUS INDUCED GRASSLAND COMMUNITIES (DANTHONIA)
RAUPO SWAMP COMMUNITIES
WIWI COMMUNITIES
FLAX COMMUNITIES
EXOTIC PLANTATIONS (PINUS SPP.)
POHUTUKAWA GROVE
TARO
NO VEGETATION ROCKS AND BARE ERODED CLIFFS
N.Z. GEOGRAPHER

Fig. 9. Major plant communities, Bay of Islands Group, 1954.

Only Ahuahu of the Mercury Islands (Iles d'Haussez) is occupied and farmed. Over three thousand acres of this formerly-forested island have experienced large-scale and extensive cultural modification. Eighteen hundred acres of indigenously-induced danthonia-dominant grassland communities cover most of the northern third of the island and a narrow fringe along the cliff tops. More than 180 acres of gorse (*Ulex europaeus*) border on parts of Huruhi Harbour, while one hundred acres of exotic pastures of ryegrass and clover are to be found, mostly at Takapau, on consolidated sands. Just over a thousand acres of manuka shrubland in the centre of the widest area of the island appear to have been disturbed less by firing and by browsing than the outer annular thousand acres, as there appears to be a greater variety of subsidiary species in the interior area. Small sections of coastal forest in steep-walled gullies, areas of wiwi swamp on hard-pan soils in interior valley floors, and narrow tongues of kanuka-tawhero (*Leptospermum ericoides-Weinmannia sylvicola*) bush along the main streams also appear to have escaped significant cultural modification. But less than two hundred acres in all have not experienced fairly substantial change (*Fig.* 12).

Of the Slipper Group, Whakahau (Slipper Island) and Penguin

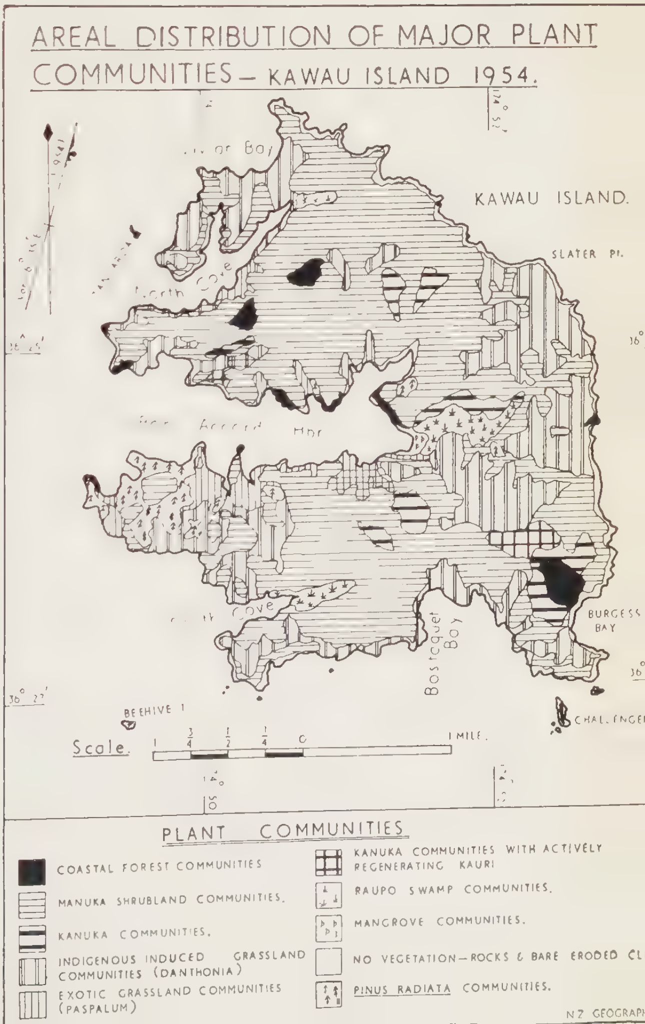

AREAL DISTRIBUTION OF MAJOR PLANT COMMUNITIES – KAWAU ISLAND 1954.
KAWAU ISLAND.
SLATER PT.
North Cove
Bon Accord Hbr
South Cove
Bostaquet Bay
BURGESS BAY
BEEHIVE I
CHALLENGE
36° 27'
Scale. 1 3/4 1/2 1/4 0 1 MILE.
PLANT COMMUNITIES
COASTAL FOREST COMMUNITIES
MANUKA SHRUBLAND COMMUNITIES.
KANUKA COMMUNITIES.
INDIGENOUS INDUCED GRASSLAND COMMUNITIES (DANTHONIA)
EXOTIC GRASSLAND COMMUNITIES (PASPALUM)
KANUKA COMMUNITIES WITH ACTIVELY REGENERATING KAURI
RAUPO SWAMP COMMUNITIES.
MANGROVE COMMUNITIES.
NO VEGETATION—ROCKS & BARE ERODED CL
PINUS RADIATA COMMUNITIES.
NZ GEOGRAPH

Fig. 10.
Major plant communities, Kawau Island, 1954.

Island have both been extensively modified as a result of farming and mutton-birding operations respectively. Rabbits have also been important on Penguin Island, and also have contributed to the partial modification of the ground layers of the well-named Rabbit Island (*Fig.* 4).

Apart from cliff faces, the whole of Whakahau has been brought into danthonia pasture over the last ninety years. Some of it has reverted to manuka shrubland, and one hundred acres of near-flat land have been drained, ploughed and sown to high-quality exotic pastures during the last eight years. Extensive grazing of sheep and of beef cattle on the rolling to moderately steep hills has continued on most of these islands almost without a break for the past ninety years. Unfortunately, regular seasonal firing of the dry fibrous danthonia in late summer has also been widely practised. Consequently, eroded faces, invasion by rushes, and the common occurrence of the sharp, unpalatable *Leucopogon fraseri* in relatively open danthonia pastures are characteristic.

Encroachment by manuka is a problem that is only partially and temporarily arrested by firing. Repeated firing gives rise to a more open pasture, but creates a more rapid runoff and causes the removal of the thin topsoil. Numerous open spaces appear and are readily colonised by manuka, *Leucopogon fraseri*, and the hardy gumland sedge (*Lepidosperma laterale*). Overstocking is generally a consequence of the depleted carrying capacity of these pastures, and in this way further opportunities occur for infestation by weeds.

The Mercury Island Group

The Mercury Island Group, spread over ninety square miles of sea, is dominated by the extreme northwestern island, Ahuahu. This island, extending for just over four miles from north to south and varying in width from under a quarter of a mile to over one and a quarter miles, constitutes eighty-two percent of the total land area of the group. Ahuahu is the only island that has been permanently occupied by Europeans for any length of time, and it is also the only one farmed at present. Like Urapukapuka, 140 miles to the north, and Whakahau, thirty miles further south, it has steep weathered cliffs, reefs and small islands along the northern and eastern seaward shores, and lower cliffed bluffs and sweeping bays of gleaming white silica sand along the landward western coastline.

Ahuahu comprises a northern area of rolling to steep pasture-covered

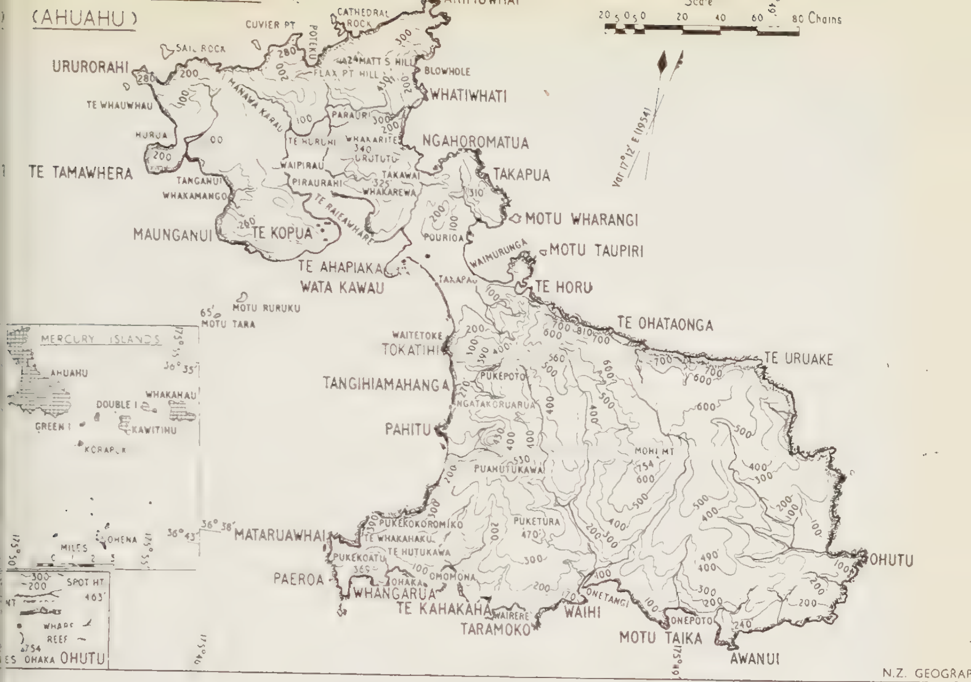


Fig. 11. Ahuahu and the Mercury Island Group.

hills and a larger, higher and more broken southern area of volcanic rocks linked by a narrow, short tract of low sand dunes and consolidated sand (*Fig.* 11). For over one and a half miles along the north-eastern coast, from Te Horu to Te Uruake, rise precipitous cliffs of white rhyolitic tuffs and finely-banded lavas reaching a maximum height of 800 feet near Te Ohataonga. Apart from steep breakaway cliffs between 100 and 150 feet high at Ngahoromatua, abrupt south-east-facing scarps at Whatiwhati and exposed dykes at Flax Point Hill (424 feet) and Matts Hill (430 feet) --known locally as 'Stonehenge'—pasture-covered rolling hills ranging between 100 and 300 feet, and with prevalent slopes of fifteen to eighteen percent, characterise this northern area. The pastures are a mixture of danthonia and browntop (*Agrostis tenuis*), except where they have been invaded by gorse (*Fig.* 12). Controlled grazing, facilitated by subdivision of this northern area into twelve paddocks, has resulted in the development of moderately good pastures which support up to three sheep per acre. Almost all the farming activity on the island is concentrated in this northern part and on the central tombolo. The cluster of farm buildings[9] and the range of farm machinery is distinctive. Two men do all the farmwork, but labour is imported for the seasonal operations of shearing, culling and shipping. Both sheep and cattle are reared on the island.

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[9] Concentrated near the wharf at Te Raieawhare are two farmhouses, shearing sheds and pens, loading pens and a ramp, a manure and tractor shed, a workshop, a storage shed and dinghy shelters.

The central tombolo, built by deposits from opposing wave action, has been drained, ploughed and sown to good exotic pastures of ryegrass, white clover, paspalum and Yorkshire fog (*Holcus lanatus*) which have a very high carrying capacity. These pastures when topdressed support five to six sheep to the acre and are used for fattening young beef, lambs and hoggets. A shelterbelt of pines (*Pinus radiata*), fifteen years old, across the centre of this near-flat area has considerably reduced the drying effects of winds which sweep across this natural wind-funnel. Consequently, invasion of dried-out pastures by thistles—an ubiquitous and troublesome weed on high fertility soils—has now been reduced. These thistles are very plentiful over most of Whakahau where the light soils dry out severely during the summer months.

South of the sandy flat between its narrow belts of sand dunes both the physiographic and the land-use patterns change abruptly. The gently-rolling pasture-covered hills of the north are replaced by a tangled mass of moderately-steep to steep hills 400 to 600 feet high. Numerous peaks, broken bare bluffs, and other rocky outcrops are common. Steeply-sloping narrow valleys and frequent severely-eroded clay patches amongst the stunted manuka growth and the deteriorated danthonia pastures are also typical. Beyond, and occupying the greater part of the southern portion of the island, is a large interior, inward-sloping manuka-covered basin. Precipitous cliffs 700 feet high along the east coast, and great masses of bare white rhyolitic rocks along the southern and western cliffs, add to the inhospitable aspect of this southern area of Ahuahu.

Maori Settlement

Ahuahu has probably been the home of men for several centuries,[10] and there is more evidence of former Maori occupation on this island than on any other outlying island of Northland. Stone and earth terraces of *pa* occur on almost every point or high hill along the entire western and southern coasts.[11] Old Maori drains can still be seen at Taupata and near a small sandy bay north of Watakawau.[12] Just east of Hurua, a *patuna*, or eel weir, which formerly covered several acres,

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[10] Maori tradition records that an early Maori navigator and his party were wrecked near Red Mercury Island and were washed ashore exhausted on the Waimurunga beach on the east coast of Ahuahu.

[11] The largest *pa* is at Te Tamawhera, where the whole of a lofty jutting headland was formerly fortified. Many of the hand-packed stone terraces are still intact, whilst dwelling sites and kumara pits are still evident as hollows in the ground.

[12] It is interesting to observe that these former Maori drains, visible after reclearing and redraining, were 'more shrewdly and advantageously placed' than those of the present occupant.

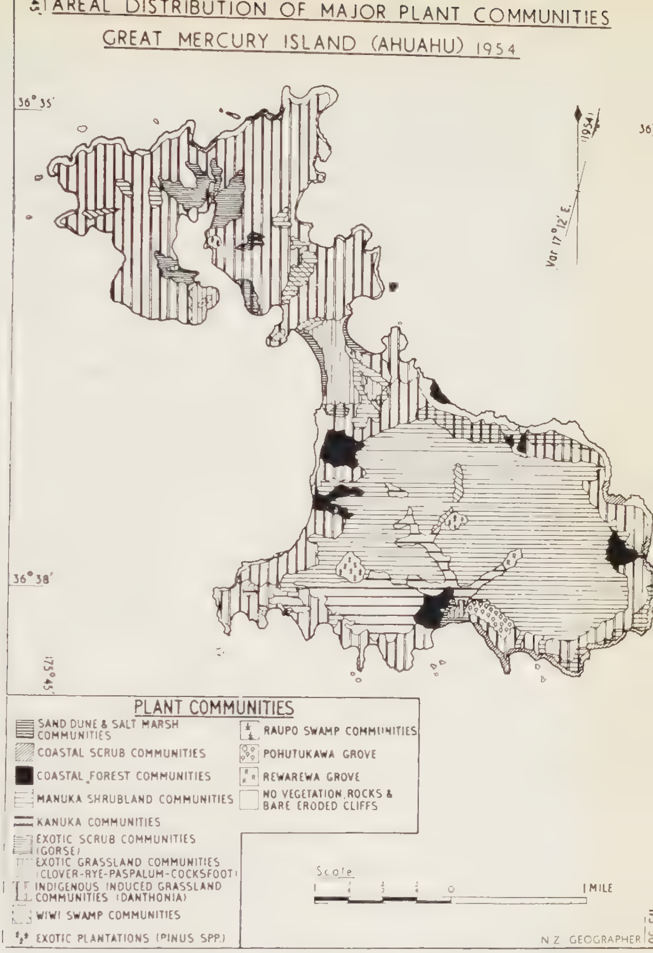
AREAL DISTRIBUTION OF MAJOR PLANT COMMUNITIES
GREAT MERCURY ISLAND (AHUAHU) 1954
36°35′
36°38′
175°45′
Var 17°12′ E.
(1954)
PLANT COMMUNITIES
SAND DUNE & SALT MARSH COMMUNITIES
COASTAL SCRUB COMMUNITIES
COASTAL FOREST COMMUNITIES
MANUKA SHRUBLAND COMMUNITIES
KANUKA COMMUNITIES
EXOTIC SCRUB COMMUNITIES (GORSE)
EXOTIC GRASSLAND COMMUNITIES (CLOVER-RYE-PASPALUM-COCKSFOOT)
INDIGENOUS INDUCED GRASSLAND COMMUNITIES (DANTHONIA)
WIWI SWAMP COMMUNITIES
EXOTIC PLANTATIONS (PINUS SPP.)
RAUPO SWAMP COMMUNITIES
POHUTUKAWA GROVE
REWAREWA GROVE
NO VEGETATION, ROCKS & BARE ERODED CLIFFS
Scale
1 MILE
N Z GEOGRAPHER

Fig. 12. Major plant communities, Ahuahu (Great Mercury Island).

is today a swamp. Maori stone walls are still intact around the fringes and, extending at regular intervals for twenty to thirty feet into the swamp, are narrow stone walls two feet above the swamp level. East and north of Whakamango—750 yards southeast of Te Tamawhera—and extending northwards to Manawa Karau, the easy rolling slopes of the peninsula formerly supported a very large Maori population. Over an area of 250 acres near Tanganui, stone walls marking *kainga* sites and cultivated plots are still largely undisturbed. Over a much wider area similar, though more disturbed, evidence of a large and industrious Maori population is not lacking, especially throughout the northern third of the island.

Captain Cook made an entry in his log about the Mercury Islands on the 15 November 1769, but did not visit them.[13] Judging from existing evidence, Ahuahu probably supported several thousand Maoris at that time. Probably all the northern third of the island was cleared. *Pa* on the crests of the steep hills, *kainga* on the lower slopes, and cultivated plots on the easier country had probably resulted in complete modification of the vegetation of large areas of the island. The easily-fortifiable peaks and headlands along the western and southern coasts as well as areas around the numerous sandy beaches had also probably been cleared of their original vegetation for many years.

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[13] W. J. L. Wharton (Ed.): *Captain Cook's Journal during his First Journey round the World made in H.M. Bark* Endeavour, *1768–1771*, London, 1893, p. 155.

Contrast between North and South

Today, over most of the northern pasture area, browntop is almost codominant with danthonia. Carrying capacity, previously less than two sheep per acre, has been increased to between three and four sheep per acre by the application of fertiliser, subdivision into paddocks, controlled grazing and the growing of root crops as supplementary fodder. In contradistinction to the northern area, the danthonia pastures fringing the cliffs and bays south of the tombolo are very poor. Improvements have not been effected here, and invasion by bracken (*Pteridium esculentum*), manuka, gorse, sedge and other weeds characterise most of these pastures. Carrying capacity is less than one sheep per acre. This southern volcanic area appears inherently infertile and will probably remain covered in stunted manuka. Topsoil is very thin and is often entirely lacking, whilst extensive areas of bare white, yellow or red clay are quite common both on easy sloping areas and on hillsides.

Occupying a central position, and accounting for two-thirds of the large southern portion of Ahuahu, is a large basin covering 1,700 acres. Drained to the south by three streams, this basin—possibly the dissected remnant of a Miocene crater—is almost completely enclosed by moderately steep red and grey clay hills which are only partially covered with thin manuka. This shrub rarely attains a height of more than four to twelve inches. Where soil conditions are better than on the steeper slopes and ridges, manuka shrubland two to four feet high grows rather more densely. Only in very localised areas where there is a noticeably better grey-brown silty clay soil does kanuka become important. The high, darker green kanuka clumps stand out conspicuously above the bare, eroded clay faces and the low, drab grey-green manuka.

Apart from some inaccessible cliff faces and steep gullies covered in coastal scrub and forest—probably remnants of the original plant cover—the remaining vegetation of this southern area has been changed considerably by man. There are no regenerating secondary forest species beneath the kanuka community.[14] If any possible clearing by Maoris is excluded, extensive digging and firing by gumdiggers in the first decade of the present century,[15] and subsequent browsing by the large numbers of goats have completely destroyed forest seed reserves.[16] Culturally-induced kanuka and manuka climax communities and danthonia communities, have replaced the original forest vegetation. In contrast to farming methods on the more northerly of the outlying islands[17] where the emphasis is upon production of wool, on Ahuahu the rearing of young beef livestock, and to a lesser extent lambs, is of equal, if not greater, importance than wool production. The progeny from 250 Polled Angus beef cows is sold each year as well as the lamb crop from almost 900 ewes. Largely owing to transportation difficulties,[18] generally dry summers,[19] and drying salt-laden winds which accentuate feed problems, store stock rather than fat stock are usually sold from the island. Some prime stock, however, is shipped to the mainland. There is a ready demand for store stock from Ahuahu by farmers on the mainland at Coroglen and Whitianga and on the foothills bordering the Hauraki Plains.

CULTURAL MODIFICATION OF AHUAHU

As is the case with the other farmed islands, Ahuahu has wide areas that have certainly experienced considerable cultural modification of the original vegetation. Probably the whole island, apart from small remnants of coastal forest, has been extensively modified by cultural agencies. The possibility cannot be excluded, however, that a considerable portion of the interior scrub-clad basin has been only partially modified by firing and gumdigging. A poor manuka community on these leached gumland podsols could have been the climax vegetation prior to human occupance of the island.[20] It is true to say, however, that this vegetation has been partially modified since the European occupants first landed on Ahuahu.

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[14] Kanuka communities generally act as nurseries in the regeneration of forest through the stages: manuka, kanuka, secondary forest species, forest.

[15] Between 70 and 100 gumdiggers took enormous quantities of kauri gum from this island. This in itself is evidence that the area was formerly forested. The remains of the foundations of an assayer's office and of a general store supplying the gumdiggers' needs are still to be seen in the sand at Motu Kawau.

[16] There are over 2,000 wild goats on Ahuahu. They were originally introduced to control the gorse, but they have preferred pasture and coastal forest. The northern cliffs are now denuded of vegetation except for small, completely inaccessible, pockets.

[17] These islands are: Ririwha, the Cavalli Islands, the Bay of Islands Group, Kawau and Aotea.

[18] The stock scow *Rahiri* serves all the outlying islands, and frequently weather conditions cause long delays.

[19] Four-fifths of the approximate annual average of 45 inches falls between April and October.

[20] The quality of the kauri gum won from the soil tends to disprove this assumption, however. Similarly Maori tradition records this area as forested in the early eighteenth century.

Ahuahu differs from the other farmed islands of Northland in several important respects. Exotic grasses and mixed exotic and indigenous pastures largely support breeding stock. Farming methods are more intensive and are mechanised, and the basic farming economy depends upon the sale of young livestock rather than upon wool production. On the other hand, Ahuahu shares with the other outlying islands the difficulties of transportation, of isolation and its attendant problems of exposure, and of dependence upon the vagaries of the sea.

In its essential features, then, Ahuahu is representative of the outlying islands of Northland, and throughout the islands there is a marked diversity of phenomena which contributes to the overall variety that is so characteristic. This combination of extreme diversity of features, difficulties, and the varied interplay of natural and cultural phenomena so vividly reflected in the existing vegetation, all contribute to the distinctive geographic personality of these islands. Despite their dispersal over many square miles of coastal waters, they are a geographic entity no matter how great or how small has been the cultural modification.

THE VEGETATION OF THE CASTLE HILL BASIN

D. H. RELPH

IN RECENT YEARS the plant cover of the South Island High Country has become increasingly a focus of research. Most of the investigations have been undertaken over very small areas, and very often have had a very specialised purpose. This study, however, is an examination of the present vegetation of a representative area of the Canterbury High Country. The Castle Hill Basin is an area of approximately eighty square miles which forms the upper catchment of the Broken River and lies within the basin of the Waimakariri River. It is about sixty miles from Christchurch and is traversed by the main road from Christchurch to the West Coast via Arthurs Pass (*Fig.* 1).

THE PLANT HABITAT

The boundaries of the area are clearly defined by the watershed of the upper Broken River, with the ridges of the Craigieburn and Torlesse Ranges and the Mt. Constitution-Broken Hill Ridge, enclosing a roughly oval-shaped area about six miles long and four broad (*Fig.* 2). This basin is almost completely enclosed by greywacke mountains which rise steeply to a general height of between 5,000 and 7,000 feet. The basin floor forms a striking contrast, most of it being between 2,000 and 3,000 feet above sea level. It consists of a series of infaulted sandy and gritty sediments, conformably overlain in places by limestone which appears in irregular outcrops that can be traced as a series of distinct escarpments, mounds and hogbacks rising 500 feet above the floor of the basin. The basin floor proper consists of a series of flat benches planed by stream action and covered with a thin veneer of gravel. These benches have been deeply dissected by streams which, in some cases, are almost a hundred feet below the terrace edge. (See Figure 3.)

In considering the natural vegetative cover, the surface configuration and structure are of considerable importance. The former largely controls local climatic conditions, and these are the most important features of the physical habitat which influence the character of the natural vegetation. Relief also affects soils. Thus the most important orographic factors which may affect vegetation are altitude, exposure

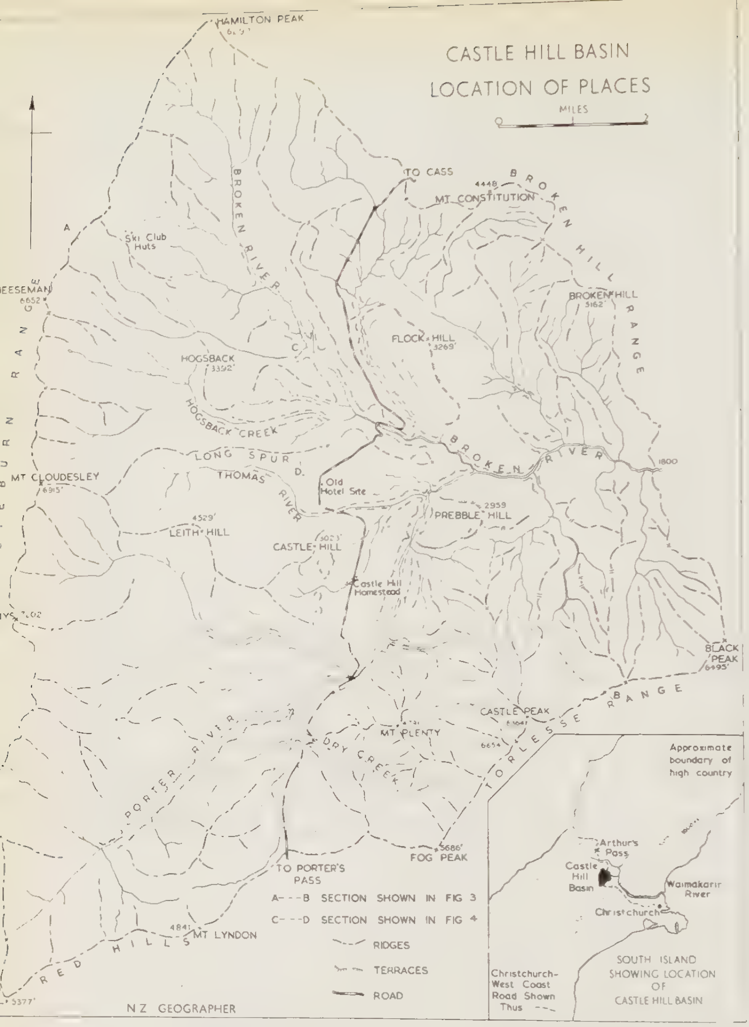


Fig. 1. The Castle Hill (or Trelissick) Basin: location map.

and slope, and within the Castle Hill Basin, some widely differing plant habitats can be attributed in part to the altitude range of over 5,300 feet —from 7,200 feet at the summit of Mt. Enys, to below 1,900 feet at the outlet of the Broken River. The only important high country community not found above this lower altitude is the Short Tussock Grassland composed of silver tussock (*Poa caespitosa*).

The importance of sunny and shady faces is accentuated in mountainous areas at high altitudes, and throughout the Castle Hill Basin examples can be found of plant communities the distribution of which is affected by the position of sunny and shady faces. Degrees of exposure to the sun result in differences in light and soil and air temperature, and also in differences in evaporation rates and in variations in soil moisture. Not only are the sunny north and northeast faces drier, but they are more exposed to winds. (See Figure 4.)

Slope also plays an important part, not only because of its direct influence on soil formation and on erosion, but because slopes tend to be drier than flats — the result of accelerated water circulation and because less snow lies on them. The flat benches on the floor of the basin contrast strongly with the deeply-cut trenches of the streams and with the steep slopes of the surrounding mountains, which, in general, range from thirty-three to thirty-seven degrees.

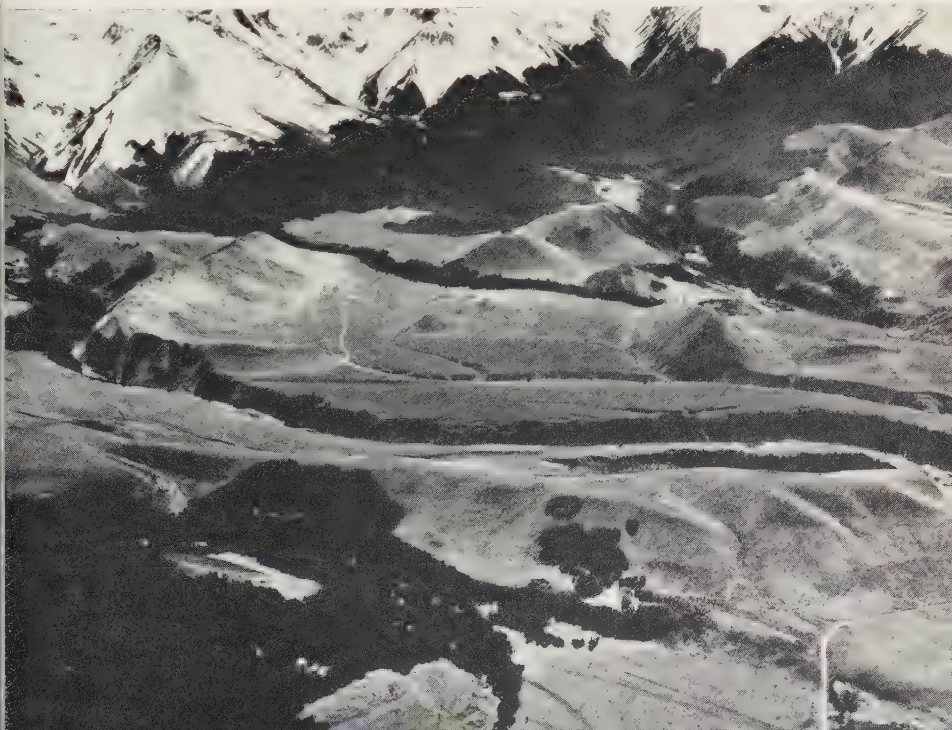
Most of the soils of the basin consist of various phases of the Kaikoura series. These are light soils which tend to be sandy in the higher and drier areas. They are powdery when dry and are very susceptible to erosion, mainly because of the greater climatic extremes, steeper slopes and lack of plant cover at higher altitudes. The highest areas consist of moving scree slopes.

CLIMATE

It is generally assumed that climate is the most important single habitat factor directly influencing plant communities, and that the chief role of most other physical features is in modifying climatic con-

. The Castle Hill Basin from the air showing surface configuration and vegetation. The dark outlines are beech forest and the lighter areas mainly tussock grassland.

Photo: V. C. Bro



ditions. The habitat range of plants appears to be largely conditioned by the rate of water loss, which is itself governed by the combined effect of humidity, wind, temperature, atmospheric pressure and radiant energy. The intensity and distribution of these factors in forming the microclimate are extremely complex. Also, their precise measurement is impossible because of the lack of meteorological data for the area.

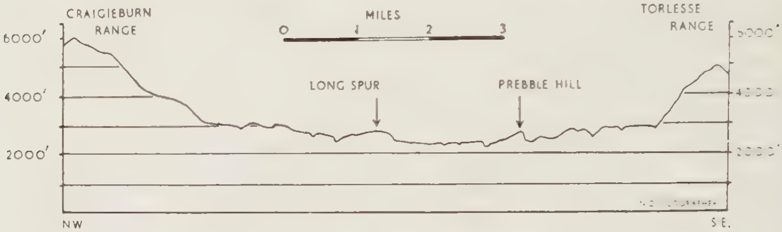


Fig. 3. Cross section of the basin.

The only records available—from the Castle Hill homestead—consist of incomplete, short-period rainfall data.

The elevation of the basin and the high relief of the surrounding mountains have an important effect on the climate, especially in modifying the force and direction of the prevailing northwest winds. Temperature and rainfall distribution in the basin can be partly explained by certain recurring atmospheric conditions resulting from these winds.

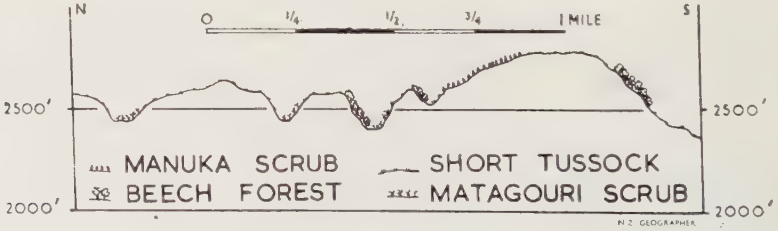


Fig. 4. Cross section showing distribution of vegetation.

Cumulus cloud tends to form at high levels in the Craigieburns, especially in the north, giving an annual rainfall of over fifty inches. However the 'nor'wester' crosses the basin as a 'drying tempest',[1] though it may give rise to some local precipitation above 3,000 feet on the Torlesse Range. (See Figure 3.) Although they are less widespread, southwest winds frequently bring cold, bleak conditions to the southwestern part of the basin.

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[1] L. Cockayne: 'Plant Geography of the Waimakariri', *Trans. N.Z. Inst.,* Vol. 32, 1899, p. 117.

The diurnal wind changes are also of importance in the climate of the basin. During the day, in settled weather, relatively warm winds tend to blow up the surrounding valleys, becoming strongest in the early afternoons and giving rise to cloud on the mountain tops. On calm nights conditions are reversed, and cold air from the adjacent snow-covered mountains tends to drain down to the floor of the basin, resulting in frequent and severe frosts. A further important climatic factor affecting the distribution of plants is the fact that ranges of both seasonal and diurnal temperatures are very great, and temperature changes are rapid, both in areal distribution and time.

All these physical factors form part of the plant environment, and it appears that under different conditions any one of them may modify the form, or limit the distribution, of a plant community.

The Beech Forests

In the Castle Hill Basin there are approximately nine square miles of beech forest (*Fig.* 5) composed entirely of mountain beech (*Nothofagus cliffortioides*). It is found only in the wetter parts of the basin, especially in the headwaters of the Broken River, where the annual precipitation is over forty inches. Ribbons of forest extend down to the drier basin floor, along the damp, shady sides of the incised streams, and in sheltered gullies on the Torlesse Range (*Fig.* 4). In places, the upper limits of the forest may reach almost 4,000 feet, an altitude which corresponds broadly with the lower limits of heavy snowfall.

The mountain beech is a fairly small, evergreen tree with branches generally forming a series of overlapping tiers. In the areas of heavier rainfall, the trees may reach forty feet in height, and the trunks a diameter of over eighteen inches. In such areas the interior of the forest is dark and gloomy, and there is little undergrowth between the tall, straight, slightly-buttressed trunks. There are no other canopy trees or lianes, and an occasional red mistletoe (*Elytranthe tetrapetala*) is the only epiphyte. At higher altitudes occasional clumps of pale green mountain toatoa (*Phyllocladus alpinus*) and totara (*Podocarpus hallii*) are present in creek beds. Apart from these, and a rare divaricating shrub on the outskirts, the only shrubs are seedling beeches. These may be abundant where light can penetrate, but in most areas they are scattered and less than one foot in height. In the damper hollows, ferns are fairly common, especially the shield fern (*Polystichum vestitum*) and *Hypolepis* *millefolium*. Mosses, lichens and the filmy fern (*Meringium multifidum*) are common in very damp areas.

However, on the outskirts of the forest, and where a certain amount of sunlight can penetrate the canopy, conditions are different. Here, regeneration is vigorous and the young beeches may form dense thickets. In drier situations, and toward the upper limits of the forest, the trees become more compact in shape, more widely spaced, and may be as low as twelve to fifteen feet in exposed places, particularly on the Torlesse Range. Although the drier margin of the forest forms an abrupt contrast to the grasslands, isolated but healthy trees in some areas indicate that much of the surrounding grasslands would probably support beech forest.

The main importance of the forest lies in its value for watershed protection, slowing down runoff and preventing soil erosion on steep slopes. Some deer are present, but in general the damage they have created is not serious. However, stock have penetrated many of the smaller forest patches and have destroyed the seedbed and the undergrowth.

Scrub Communities

Scrub communities in the Castle Hill Basin are discontinuous and scattered, but they are frequent in a wide range of habitats (*Fig.* 5). Although they all show certain similar characteristics (notably varying degrees of xeromorphy), there are several species which dominate in different habitats, and give a distinctive physiognomy to the community.

The greyish colour and ragged form of the matagouri (*Discaria toumatou*) is characteristic of dry shingly areas such as the partly-consolidated shingle slides at the base of Mt. Plenty. There it forms dense thickets, but it is also scattered along the steep sides of the riverbeds, generally on the more exposed and sunnier faces. It is uncommon above 3,100 feet. Although the matagouri communities, because of their impenetrability, perform a valuable function in consolidating shingle, they were probably much burned in the early days of settlement, and as a result accelerated erosion occurred in some of the steeper gullies.

Drab, brownish patches of manuka (*Leptospermum scoparium*), three to five feet in height, are common, especially on certain sunny faces, and on the porous sandy soils of the Cretaceous-Tertiary beds in the north of the basin below 2,800 feet. This shrub appears to be a successional stage in the development of other communities, and, in combina-

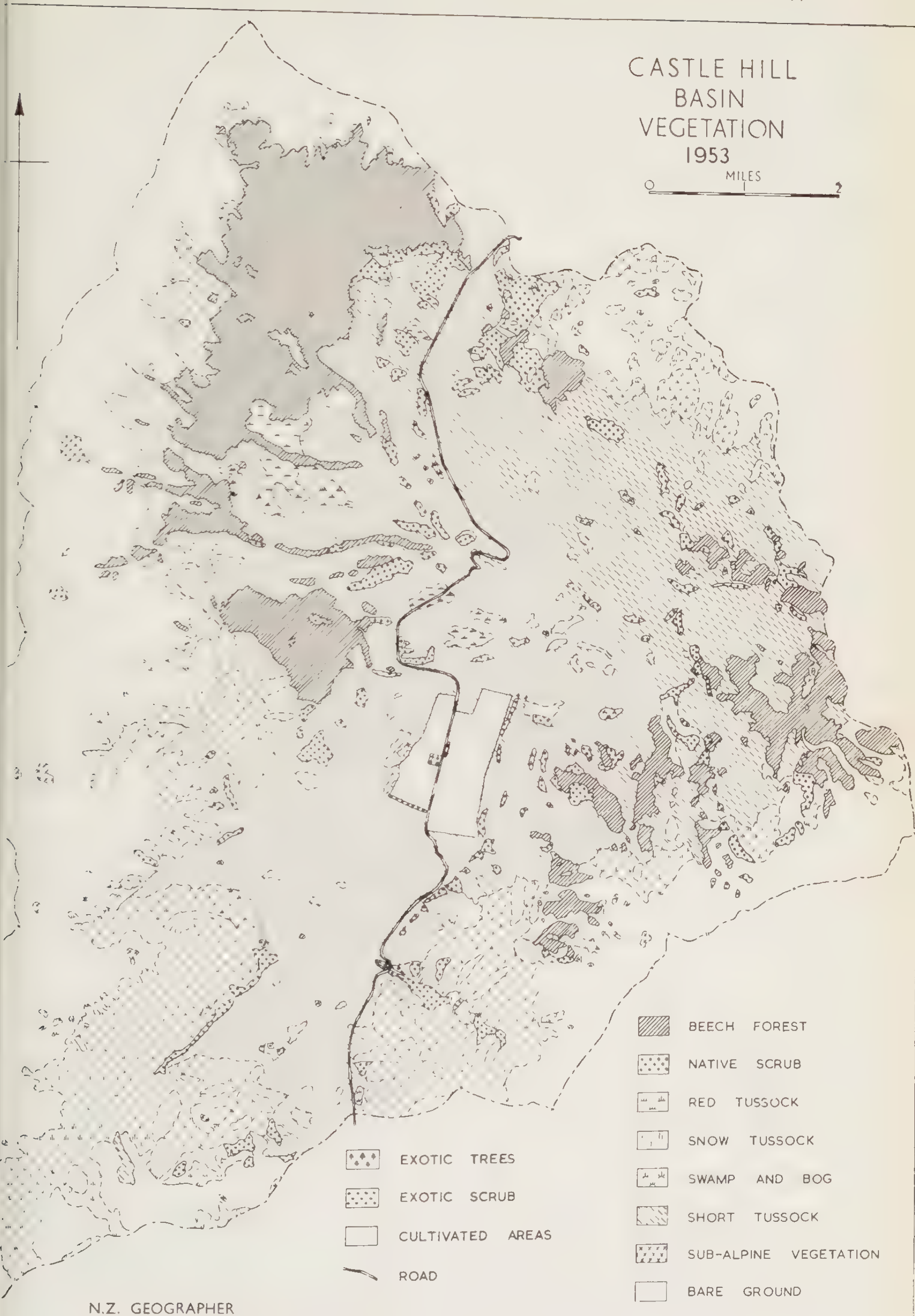

Fig. 5. The vegetation of the Castle Hill Basin, 1953.

tion with taihinu (*Cassinia fulvida*), is probably in most cases an indigenously induced community. Nevertheless, it plays a valuable part in providing a nursery for forest communities and in reclothing relatively bare soils. But from the point of view of the runholder it is of little use. Besides making access difficult, the manuka plant is unpalatable, and is often thought to be covering ground which would otherwise be supporting grasses. For this reason, most of it has been burned at some time, although in the long run this has probably facilitated its spread.

Subalpine scrub, consisting almost entirely of the strongly xeromorphic turpentine bush, or grass tree (*Dracophyllum*), forms highly distinctive communities in restricted localities, particularly on shady faces above 3,500 feet. These communities are of little value for grazing purposes, and have probably been reduced in extent through fire. However, this lack of food value is probably outweighed by their virtue in protecting the soil in an inhospitable environment.

Alpine Communities

At high altitudes herbfields and fellfields form distinct, though scattered, communities of small areal extent. Most of the virgin alpine communities have probably been destroyed by man's activities, but there are some remnants which are probably little different from the virgin forms. The fellfield vegetation is of a very open character, made up largely of xerophytic shrubs forming isolated spreading mats or low cushions. Mountain totara (*Podocarpus nivalis*) is especially prominent on partly-consolidated shingle slides. The herbfields are largely confined to damp shady slopes and hollows above 4,000 feet, especially on the floors of cirques. They usually consist of more or less pure colonies of one or more species of mountain daisy (*Celmisia* spp.). *Celmisia viscosa* is often most abundant and forms large silvery-green mats several yards in diameter. At lower levels the cotton plant (*Celmisia spectabilis*) has increased at the expense of the grasslands as a result of burning. Although these communities have a restricted distribution in relatively inaccessible habitats they play an invaluable part, in the successions at the upper limits of vegetation, as stabilisers of the shingle.

Of minor importance are the small bog communities which are restricted to poorly-drained depressions, the foot of steep slopes and the edges of streams. The most common bog communities are dominated by the reddish tussocks of the sedge *Schoenus*.

Tussock grassland communities cover by far the largest part of the

Castle Hill Basin. The tall tussock grasslands have a similar physiognomy throughout, but in spite of hybrid species, red tussock communities can in most cases be readily distinguished from the more common snow tussock areas. The red tussock (*Danthonia rubra*), is usually regarded as an indicator of cold, sour soils, and the tall, fine-leaved, closely-spaced tussocks are common in small areas of poorly drained country below 3,000 feet.

Tall Tussock Grasslands

The snow tussock (*Danthonia flavescens*) grasslands are the major community clothing the higher slopes in the Castle Hill Basin. The tall, dense, brown-green tussocks range in height from four feet to stunted forms of less than one foot at the highest altitudes. The widely-spreading canopies of individual tussocks may cover an area of up to twenty square feet, and in places may be so closely spaced as to form an almost continuous cover to the ground. But usually some inter-tussock vegetation is present, the species composition and appearance varying according to differences in the physical environment or in management practices. Smaller hard tussocks (*Festuca novaezelandiae*) and blue tussocks (*Poa colensoi*) are always present, and in the wetter parts various species of *Celmisia* are common, as well as the large snow gentian (*Gentiana corymbifera*).

The vegetation of those areas which are drier and more accessible to stock is much less dense and colourful. The tussocks are smaller and more widely spaced, and on the steep ridges in particular, between thirty and sixty percent of the intervening spaces may consist of bare ground. The small tussocks may be more prominent, together with mats of carpet grass (*Danthonia australis*) and snowberry (*Gaultheria depressa*).

At the lower altitudes the transition to short tussock grassland is usually abrupt—rarely extending through more than a hundred feet of altitude. This lower limit varies with aspect. Along the sunny slopes of the Torlesse Range it is between 3,400 and 3,700 feet; on some shady slopes it extends to below 3,000 feet. The upper limit has also been lowered several hundred feet because of fire and grazing, and in most parts of the area the snow tussock becomes discontinuous and gives way to scree at altitude of between 4,500 and 5,000 feet. Although the snow tussock is grazed after it has been burned, and the blue tussock is eaten to some extent, the snow tussock community is not important for grazing. However, it plays an important part in preventing erosion on the steep slopes at high altitudes, and where it has been interfered with by fire or overgrazing, the surface has been rapidly bared and soil erosion has resulted.

Short Tussock Grasslands

Short tussock grassland is the most important and widespread type of vegetation in the Castle Hill Basin, covering thirty-seven percent of the area. The narrow-leaved, yellow-brown tufts of the hard tussock everywhere dominate the vegetation below the level of forest and snow tussock. Although they may be stunted and widely spaced on the drier and more exposed flats, the tussocks usually range in height from ten to twenty inches, with the smaller, denser blue tussock also widespread.

Apart from variations in the spacing of the tussocks, the physiognomy of this community shows certain variations as a result of the relative abundance of exotics as intertussock species. In particular, a clear distinction can be made between the grasslands of the lower and sunnier country, which are characterised by a predominance of exotic species, and the grasslands of the higher and colder or more exposed places, in which native species largely replace the exotics. The transitional zone may be fairly narrow on the steeper slopes, although it is more gradual on the flat areas.

In the areas where indigenous species predominate, several native grasses are common, especially blue grass (*Agropyron scabrum*). A number of small native herbs[2] are present, but usually most of the ground is covered by the small mat-forming plants such as the tiny dwarf heath (*Leucopogon fraserii*), mountain snowberry (*Gaultheria depressa*) and scabweed (*Raoulia subsericea*). The only important exotic is catsear (*Hypocheris radicata*), and relatively large areas consist of bare ground. In the lower and milder areas where exotic grasses have become established, the grasslands differ markedly, both in species composition and in physiognomy. Usually the intertussock spaces are filled with a dense cover of sweet vernal (*Anthoxanthum odoratum*) and browntop (*Agrostis tenuis*) which often cover over two-thirds of the area, and leave little bare ground. However, the small native herbs are still present amongst the grasses, along with varying amounts of matagouri.

The life forms of the main grassland species illustrate the relatively harsh nature of the environment. Xerophytic adaptations such as the cushion, mat, rosette, small leaves, and creeping or divaricating habit are prominent throughout. In most parts, the tussock appears to be a climax form, with the tussocks providing protection for the more mesophytic and more palatable intertussock species. However, fire and grazing have opened up the tussock grasslands, allowing a dense cover of exotic grasses to enter in the milder areas, and, in the higher areas to revert to an earlier stage in the succession, with mat plants more prominent. The increased altitudinal range of the short tussock grasslands at the expense of the tall tussock grasslands has already been mentioned with particular reference to sunny slopes. Similarly, the economically more important exotic grasses extend to high levels on the sunny, sheltered faces of the Torlesse Range in particular, but may be relatively rare on some cold, exposed flats at altitudes as low as 3,000 feet.

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[2] Especially common are *Whalenbergia gracilis, Viola cunninghamii, Senecio bellidioides, Celmisia laricifolia,* and *Brachycome sinclairii.*

Apart from their importance in checking accelerated erosion, the chief value of these grasslands lies in the relative abundance of the more palatable species. The tussock is mainly of value in sheltering the smaller species, though the blue tussock is palatable. Also, the dominant exotics are of only moderate palatability, but do provide useful cover to prevent soil erosion. In general, the lack of palatable species of pasture plants in the Castle Hill Basin makes the grazing value of the short tussocks comparatively low.

Bare Ground

The vegetation map shows large areas of the Castle Hill Basin that are almost bare of vegetation. In these the growth of plants is inhibited by the extremely harsh conditions—temperatures may be extreme, soil or soil moisture may be lacking, the substratum may be unstable, or the vegetation may have been unable to regenerate after destruction by man. However, they do include some plant communities, often of very distinctive character.

Especially notable are the scattered specimens of small, very xerophytic grasses and herbs found on the scree slopes at high altitudes. Here the environment is extremely harsh because of rapid and extreme temperature changes resulting from the poor conduction of heat by the talus, extreme conditions of exposure, and the continual movement of scree, for most of the slopes are greater than thirty-two degrees. The hard, greyish-white cushions of the vegetable sheep (*Raoulia eximia*) form another distinctive community on rocky outcrops on sunny faces between 4,700 and 5,300 feet.

The limestone cliffs and debris are also the home of several distinctive plant communities, such as the dense, pale-green carpets formed by the tiny grass *Poa acicularifolia.* Similarly, the riverbeds are the home of other distinctive plants, the species varying with the stability of the shingle, various species of scabweed perhaps being most common.

Exotic Communities

Exotic trees and shrubs are relatively unimportant in the Castle Hill Basin, mainly because of the nature of the environment. However, the three patches of exotic trees which are found there are important not only for their shelter but because they give an indication of the ability of certain species to survive. A plantation of *Pinus radiata* has grown very slowly on the exposed flats round the Castle Hill homestead, though plantations of larch (*Larix decidua*) and *Pinus laricio* are thriving round the old Enys homestead. Here a number of trees planted about 1870 are more than eighty-five feet in height. These include larches, Wellingtonias (*Sequoiadendron gigantea*) and *Sequoia sempervirens.*

A patch of stunted gorse round the site of the old Castle Hill hotel has spread little in the last fifty years—again an index of the severity of the environment. Several paddocks of exotic grasses have been established, including some sown with high-quality species, and are used for hay as well as for permanent pasture. However, a continuous cover does not form readily and there is much bare ground. Crops of turnips are grown fairly successfully, and in 1952-1953 a crop of oats reached three feet in height. Although the paddocks of sown grass and crops stand out in the landscape, only relatively poor-quality exotic species appear to be able to establish themselves successfully, and even weed communities are prominent only where the native communities have been disturbed.

Value of the Plant Cover

It has frequently been suggested that the chief function of the vegetative cover of the high country as a whole is to protect the watersheds of the rivers which extend across the lowland, and because of this, all stock should be removed in order to allow the cover to regenerate, and so form a more effective barrier to excessive runoff and accelerated erosion.[3] There is some justification for this suggestion as far as the

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[3] This point of view is discussed in G. Jobberns: 'South Island [New Zealand] High Country', *Proc. A.N.Z.A.A.S.*, Section P, Hobart 1949, p. 156.

Castle Hill Basin is concerned because the whole basin is situated at a high altitude. The dryness and severity of the climate make the steeper slopes particularly vulnerable to accelerated erosion, and increase the risk of high death rates among stock and of crop failure. The chief function of the beech forest, in particular, is watershed protection. For this reason its maintenance is of prime importance, and its effectiveness would be greater if the undergrowth could be increased. This would involve a stricter control of both cattle and sheep, as well as of deer and chamois. Similarly, at high altitudes, the aim must obviously be to retain the present plant cover and to prevent further encroachment of scree by removing all grazing and browsing animals.

Because the tall tussock communities are developed mainly on the steeper and higher country, above the winter snowline in most cases, their grazing value is limited, and they are particularly susceptible to depletion and obliteration by scree. Most of the sunny slopes are already depleted to varying degrees, and in particular the Red Hills area, the higher parts of Broken Hill, and sections of the Torlesse Range are very seriously depleted. However, a fairly dense cover is often present on the shady slopes and in the relatively inaccessible areas above the bushline in the northwest. It appears that in order to permit natural regeneration of the cover a more strict control of stock would be necessary. This could be achieved by subdividing these areas more closely in order to prevent stock from concentrating on the sunny slopes during the summer. However, fencing would be both difficult and costly, and frequent snow and frost lift would create problems of maintenance. Indeed, it would appear at present that the most satisfactory means of maintaining or improving the existing cover is completely to remove all stock from all snow tussock areas.

In the short tussock grasslands, similar conclusions must be reached concerning the higher and steeper areas of predominantly indigenous grasses. However, where exotic grasses are established, moderate, continuous grazing by sheep appears to have no harmful effects. Grazing is the only use to which most of the short tussock grasslands can be put if a reasonable economic return is required. Some of the more sheltered flats could be cultivated and possibly irrigated—but only to provide supplementary feed.

On the poor soils in the moister areas to the north, frequent burning has increased the extent of the bare ground and has facilitated the establishment of mixed scrub. In some places, this scrub is becoming so dense as to hinder access by stock. This presents the problem of whether to burn the scrub on the steep faces and run the risk of accelerated erosion, or to abandon the whole area for the purposes of grazing. The latter course may be uneconomic for the runholder, but with the long-term view of protecting the cover, it is possibly the wisest choice, especially when the scrub shows signs of acting as a nursery for seedling beech.

Future Development

It will be quickly realised that the above suggestions, if carried out, would give rise to serious economic problems. If both scrub and tall tussock areas were abandoned and the areas available for grazing were restricted to those outlined above, it is doubtful if the sheep stations concerned could be run economically under the present systems of management. Two alternatives would be available: either the whole basin could be abandoned, or some method of improving the management practices would have to be found.

If the area were closed up there would still remain the risk of guarding against accidental fires which would have serious consequences once the cover had increased. Rangers would have to be employed continually to protect the forests and higher slopes from damage caused by increasing numbers of deer, chamois and opossum. Little economic return would be coming from the land, and the returns from 7,000 to 8,000 sheep would be lost. Many methods of improving present management have been suggested—amalgamation of runs, governmental control, and a more secure system of leases. As far as improving the economic value of the existing plant cover is concerned, several possibilities may be considered. Studies of the nutritive value of high-country pastures[4] indicate that the present cover has an extremely low nutritive value. Also the high altitude and severe climate of the Castle Hill Basin imposes severe limitations on the establishment of more valuable plants, such as flatweeds (especially catsear), clovers, lucerne and later-maturing grasses such as Yorkshire fog (*Holcus lanatus*). Experiments are now being carried out in the Castle Hill Basin in an attempt to solve this problem.

In the more seriously depleted areas, spelling would be invaluable for increasing the cover, as is illustrated by the fact that four small plots fenced by the North Canterbury Catchment Board showed an overall decrease in the area of bare ground of 5.2 percent in five years. Perhaps the most useful way of increasing carrying capacity is to increase winter feed, because the carrying capacity is governed by the availability of feed when growth has stopped and snow is present. Some root crops, and even oats, have been successfully grown in the Castle Hill Basin, and the area of cultivated land could be considerably extended. However, cultivation provides the problem of directly exposing the light, friable soils to wind action. In addition, root crops, which remain in the ground throughout the winter, are liable to be frozen solid, and therefore inaccessible to sheep, for considerable periods after frosts. Thus, while these crops have their usefulness, an increased concentration on the growing of hay would provide a more satisfactory answer to the winter feed problem. Nor should the possibilities of the irrigation of crops such as lucerne be neglected. Although most of the streams are entrenched, rivers such as the Thomas could probably be successfully utilised.

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[4] I. E. Coop: 'Nutritive Value of Some High-Country Pastures', *Proc. N.Z. Grasslands Assn.*, 1952, pp. 109-113.

The planting of shelterbelts across the exposed flats would not only provide shelter for stock and crops, but would also reduce wind erosion of the soil. Observations from an exposed experimental plot at Cora Lynn in the upper Waimakariri and from the Castle Hill homestead indicate that several coniferous species can be successfully established below 2,800 feet, even in the more exposed areas, particularly larch, Douglas fir (*Pseudotsuga taxifolia*), *Pinus muricata, P. radiata* and, especially, *P. murrayana.*

It appears, then, that if the Castle Hill Basin is not to be closed up, and the cover on the higher slopes is to be preserved, carrying capacities can best be maintained by increasing the amount of cultivation. There are large areas which can be grazed consistently, especially towards the east on the rolling country on each side of the Broken River. Considerable areas, especially the flats along the foot of the Craigieburns, can be grazed more lightly with frequent spelling. These conclusions are derived purely from consideration of the character of the vegetation —of its present composition and condition, and of its potential condition. It must be admitted that they would need modification in the light of other factors such as finance, labour, fencing and bridge-building. Nevertheless, the state of the vegetation provides a key to land capability.

TAUPO
AND THE CENTRAL NORTH ISLAND

R. GERARD WARD

THE AREA within a radius of thirty miles of Taupo is the scene of several of the major development operations now taking place in New Zealand. Almost forty percent of the new farmland broken in annually is situated within this area, and here are the sites of two of the largest hydroelectric power stations under construction and of the country's first geothermal station. In addition, exotic and native forests are providing timber for a growing milling industry. These new and expanding activities have given rise to a marked growth of population throughout the central portion of the North Island, and the towns of Rotorua, Putaruru, Tokoroa and Mangakino have ranked among New Zealand's most rapidly growing urban areas.

More recently, the centre of the major development activities has shifted southwards and they are now affecting the growth of Taupo. The town had a higher rate of population growth between 1951 and 1956 than any other borough in the country. Today, therefore, Taupo is in the midst of change and is in many ways typical of the older centres of the central North Island which are experiencing sudden expansion after a long period of slow growth. Like these other centres, Taupo was for long dependent upon the tourist trade, while its hinterland remained virtually uninhabited. Now, however, it has added the functions of a milling and a construction town, and is becoming increasingly significant as a servicing centre for the surrounding district.

Lying on the northeastern shore of Lake Taupo, the town is situated on the main north-south highway through the centre of the North Island, near its junction with major roads to Napier and Rotorua and the Bay of Plenty (*Fig.* 1). Tokoroa, forty miles to the northwest by road, is the nearest town of any size, while Rotorua and Mangakino are the only other towns within sixty miles larger than Taupo. Taupo is well situated, therefore, to serve a considerable portion of central North Island.

Increasing Population

In 1945 the town of Taupo had 753 inhabitants, but within eleven years the population has increased by 292.6 percent to 2,839, while an additional 400 persons now live in the settlements immediately adjacent to the borough boundary. The growth of population has not been steady throughout the eleven years (*Fig.* 2). The first intercensal period, 1945-1951, saw an increase of eighty-eight percent with the population rising to 1,358[1] while during the period 1951-1956 the increase was 110 percent, a rate of growth which made Taupo the fastest-growing borough in New Zealand.[2]

One indication of the variation in the rate of growth during the period 1945-1956 is provided by the school roll (*Fig.* 2). The first period of significant growth was from 1949 to 1953 and was connected with the influx of population which accompanied the beginning and early expansion of the Wairakei geothermal project and the establishment of three new timber mills within the town. From late 1953 to early 1955 the rate of growth slackened, but this period was one of consolidation. New shops and offices were erected, power was made available, a street-sealing programme was inaugurated and a local newspaper established. During 1955, the population of nearby land-development blocks was increasing, and, towards the end of the year, work was begun on the building of a geothermal power station. These developments resulted in a further influx of population, and the school roll rose at an unprecedented rate throughout 1956.

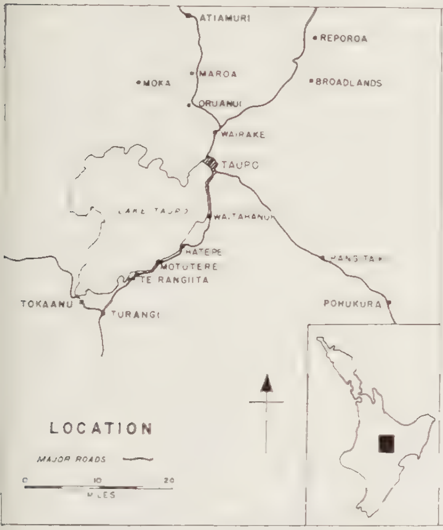
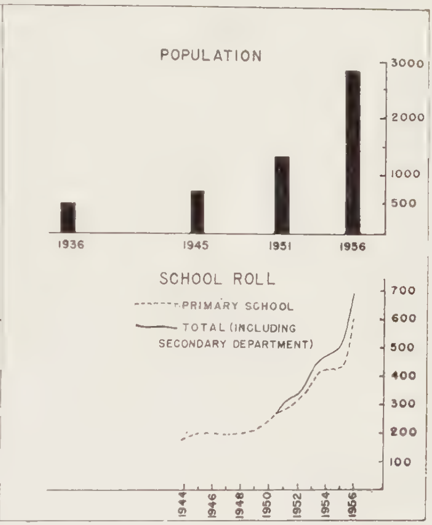


Fig. 1. The location of Taupo.



N.Z. GEOGRAPHER

Fig. 2. Population growth, 1936–1956.

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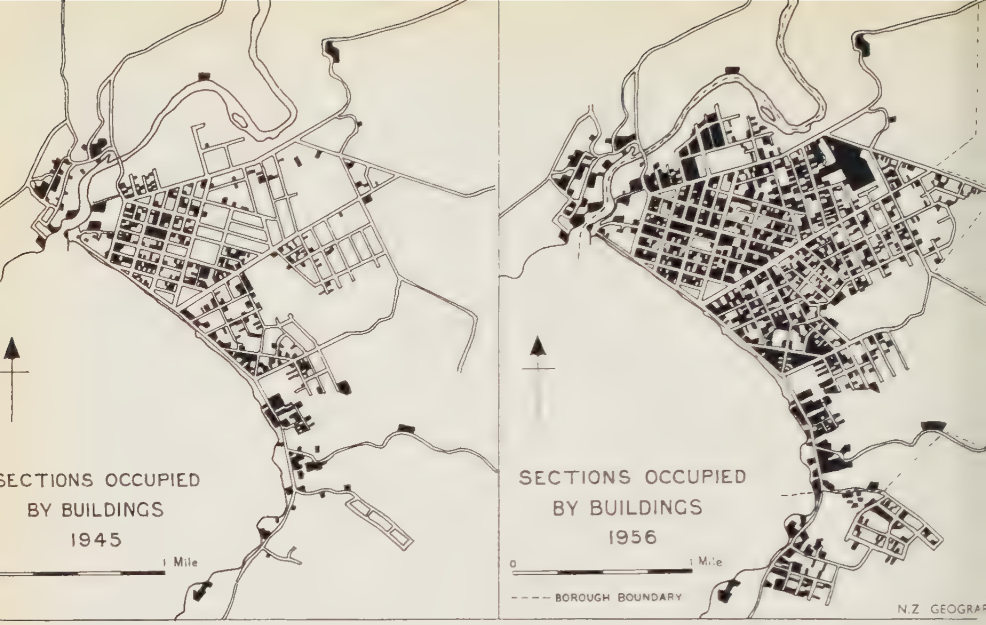
[1] This rate of growth was exceeded only by Mt. Maunganui (89 percent), Tokoroa and Mangakino. Mangakino did not exist in 1945, while Tokoroa had a population of approximately 130 and was thus too small to be differentiated in the census of that year.

[2] Kawerau, with a population of 2,729 in 1956, did not exist in 1951 and is therefore not included in the above statement.



gs 3 and 4. The development of building and growth of Taupo, 1945–1956.

The rapid growth in population has been accompanied by considerable changes in the form of the town. The most notable is the extent to which the borough has been built up (*Figs.* 3 and 4). In 1945, large blocks remained unused, but since then the number of permanent residences has increased fourfold, and most building has taken place in the middle portion of the town. In addition, many holiday cottages in this part of the borough have been converted into permanent residences. The majority of the newer holiday cottages have been erected in the eastern parts of the borough and outside its boundaries where land is cheaper and rates are lower. As most of the visitors to these cottages have cars, the distance from the shops is no great handicap during their relatively short periods of residence.

Taupo's function as a construction town is reflected in the camp for single men situated in the northwest corner of the borough. Nearby, a group of over eighty houses of Ministry of Works pattern provide accommodation for married staff employed on the Wairakei geothermal project. These two 'settlements' are distinctive within the borough but are typical of the construction camps now characteristic of central North Island.

Despite the amount of building which has taken place in the last eleven years, many sections remain unoccupied, even close to the main street, and the town is spread over an excessive area (*Fig.* 5). Within the borough are more than fifty-three miles of streets and the problems of power and water reticulation and street sealing are multiplied by the low density of population per mile of road.[3]

As the form of the residential parts of the town has changed, so has that of the business section (*Fig.* 6). In 1945, old buildings and empty sections were typical of the main street (Tongariro Street) but many of the old structures have now been replaced by modern blocks of shops and offices and little of the frontage now remains unused. In addition, business premises have been built in several streets to the east of Tongariro Street, and in some instances houses have been converted into offices. Apart from the sections occupied by the post office and Memorial Hall, the entire western side of the street is devoted to sports grounds and reserves. The municipal camping ground, which formerly occupied much of this area, has been moved to a more extensive site to the north of the sports grounds.

Tourists

The functions of contemporary Taupo fall into four major groups: those of a tourist centre, a timber-milling town, a construction town and a commercial centre. Prior to 1949, Taupo was almost entirely dependent on the tourist trade with fishing and thermal activity providing the major attractions. Each year saw a large influx of visitors over the Christmas and New Year period, with minor peaks during the school holidays in May and August. Between these brief periods of activity were long spells when the life of the town continued at a much slower tempo. Since the 1939-1945 war, the number of visitors

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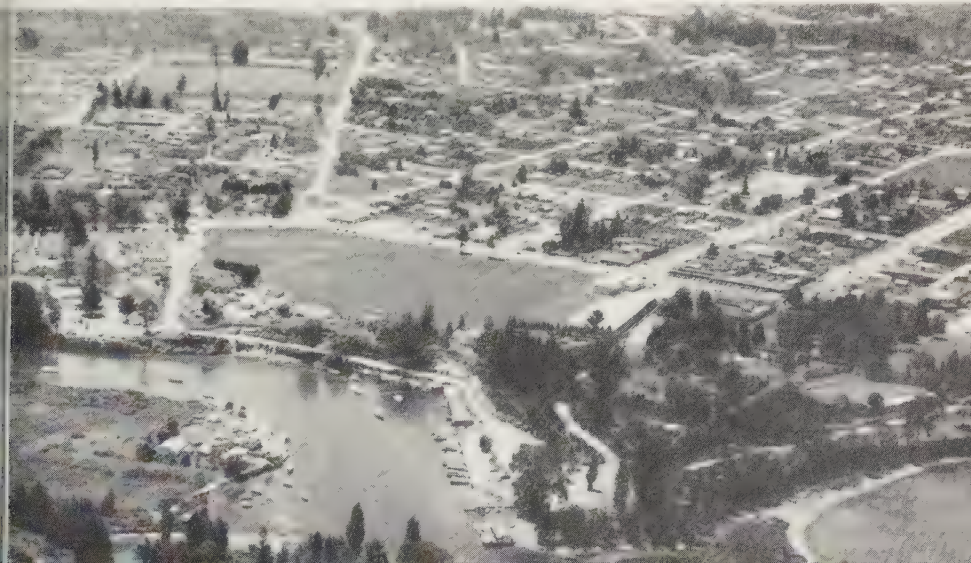
[3] There are only 54 persons per mile of road in Taupo. Compare this with 565.4 persons per mile at Tokoroa.

Aerial view of Taupo looking northeast: the Waikato River in the foreground and the business area in the middle distance.



during off-seasons has increased considerably as improved road transport enabled bach owners from as far as Auckland and Wellington to spend weekends in Taupo. The fact that there was no closed season for fishing during the winters of 1954 and 1955 helped to attract more visitors to the town and district during the months from June to October. Nevertheless, an overwhelming majority of the visitors to Taupo, and to an even greater extent to the surrounding district, still arrive during the summer months.[4]

It appears that the summer population of Taupo is approximately double that of the off-season. Thirty-one percent of the houses within the borough are holiday cottages, and these are likely to accommodate some 1,500 persons during the peak of the season.[5] Each night during the Christmas and New Year periods of 1954-1955 and 1955-1956 over 1,000 people have camped in the borough's two motor camps. These figures, together with those of the 400-odd guests at hotels, boarding houses and motels, and the permanent residents, indicate that from late December to mid-January the population of the borough approximates 6,000.[6]

In addition to visitors staying within the borough are those in cottages and camps along the eastern lakeshore. At least 4,000 visitors are likely to be resident here in mid-summer, as well as 1,700 permanent inhabitants. Many of the cottages and most of the camp sites are occupied by more than one party during the holiday period, and the total number of visitors is likely to be over 16,000. For a large proportion of these visitors, Taupo becomes the immediate source of their food and other supplies.

SOURCE OF VISITORS

Taupo's central location, together with the greatly-improved roads of recent years, makes it easily accessible from almost all parts of the North Island. As a result, no single district provides an overwhelming proportion of the visitors. Nevertheless, Hawkes Bay contributes a greater proportion of the regular visitors than does Auckland, while Wellington holds third place (*Figs.* 7 and 8). The link with Hawkes Bay dates from the time of the earliest settlement at Taupo. In more recent years Auckland has provided an increasing number and proportion of visitors and this tendency will probably continue as improved roads cut down travelling time. It is significant that Auckland provides more of the visitors to the northern end of the lake than does Wellington, while at the southern end the reverse is true. Similarly, people from the Manawatu tend to visit the settlements around the southern end of the lake while few of those from the Bay of Plenty and the Waikato go further south than Hatepe. The camping population is far more transient and mobile than the cottage dwellers, and no single district forms the predominant source of visitors. The town's central location makes it a convenient overnight stopping place for tourists on a general tour of the North Island or en route between Auckland and Wellington. Today Taupo is not nearly so dependent on the tourist trade as in the past, nevertheless the hotels and boarding houses still employ almost as many people as does the timber-milling industry.

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[4] Occupancy rates of the hotels at Taupo and Wairakei indicate that 65 percent of all visitors come during the months of December to April inclusive. (F. Spence: *A Geographical Study of the Tourist Industry of New Zealand,* Unpublished M.Sc. Thesis, University of New Zealand, Auckland, 1955.) The visits of the camping population are concentrated more in December and January.

[5] This, and the other estimates, are likely to be conservative.

[6] Evidence to support this figure of double the permanent population is found in statements by local storekeepers that sales of foodstuffs in December and January are approximately double those of June and July.

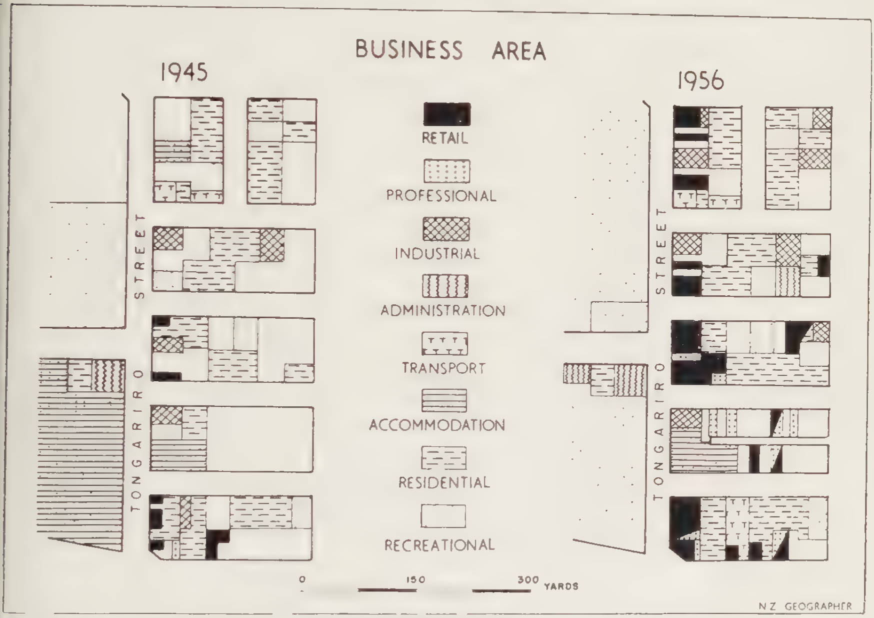

Fig. 6. Land use in the central core of Taupo, 1945 and 1956.

Timber

In 1945 only one timber mill was operating in Taupo, and only native timber was cut. Today there are five mills and *Pinus radiata* accounts for an increasing proportion of annual production. Employing an average of twenty-one men, exclusive of bush and transport workers, and with an average annual production of 2,440,000 board feet, the mills are large by New Zealand standards. All are located near the northern edge of the town where ample vacant land was available and land costs were relatively low.

Only two of the mills cut native timber, only one exclusively, and the three newest mills have all been designed to deal solely with exotic timbers. The remaining stands of native bush within an economic working radius of Taupo are limited, and already logs are brought more than thirty miles by road from bush to the east. On the other hand, large exotic plantations are available within ten miles, and already radiata pine accounts for fifty-six percent of the twelve million board feet cut annually in the town. The expansion of production and the increasing importance of exotic timbers are trends which are typical of most milling centres of central North Island.

Of the total output of timber, less than ten percent is used locally. This proportion may increase as construction work at Wairakei is accelerated, but even then most of the timber will have to be sent to more distant markets. In this, Taupo's central position enables it to serve the densely-populated and timber-deficient districts of Auckland, the Waikato, Hawkes Bay and Wellington. At present, forty-four percent of the total sawn timber output goes to Auckland and the Waikato, thirty-four percent to Hawkes Bay, and twelve percent to Wellington. The role of the timber industry in the growth of Taupo has been considerable, for it has expanded steadily and has helped to counteract the highly seasonal character of an economy largely based on the tourist trade.

THE WAIRAKEI GEOTHERMAL PROJECT

Undoubtedly the most important single factor in the growth of Taupo in the last five years has been the Wairakei geothermal-steam project. Begun in 1950, this project has brought a considerable influx of workers into the district, and until now the majority have settled in Taupo and have travelled daily the five miles to and from work. On the other hand, the employment in and near Taupo which this project has offered largely accounts for the decline in the population of Waitahanui by over twenty-six percent between 1951 and 1956. Regular employment and accommodation have encouraged people to move into the town.

Late in 1956 more than 350[7] men were employed directly or indirectly on this undertaking but it is likely that this figure will be increased by a further 300 by the end of 1957 when the construction of the power house should be at its peak. Most of these new workers will be housed in a new settlement at Wairakei, but Taupo will be the nearest commercial and social centre. The scheme already provides employment for three times as many people as the next major activity in Taupo, namely the timber industry. Its importance will increase in the next few years, but although continued drilling will be necessary in the Wairakei area, the present intensive construction activity is essentially temporary. By the time the first and subsequent power stations have been built close to Taupo, most of the surrounding land should have been settled by sheep and dairy farmers, and the extra facilities necessary to serve this new rural population should ensure that the town will not suffer any significant decline in population.

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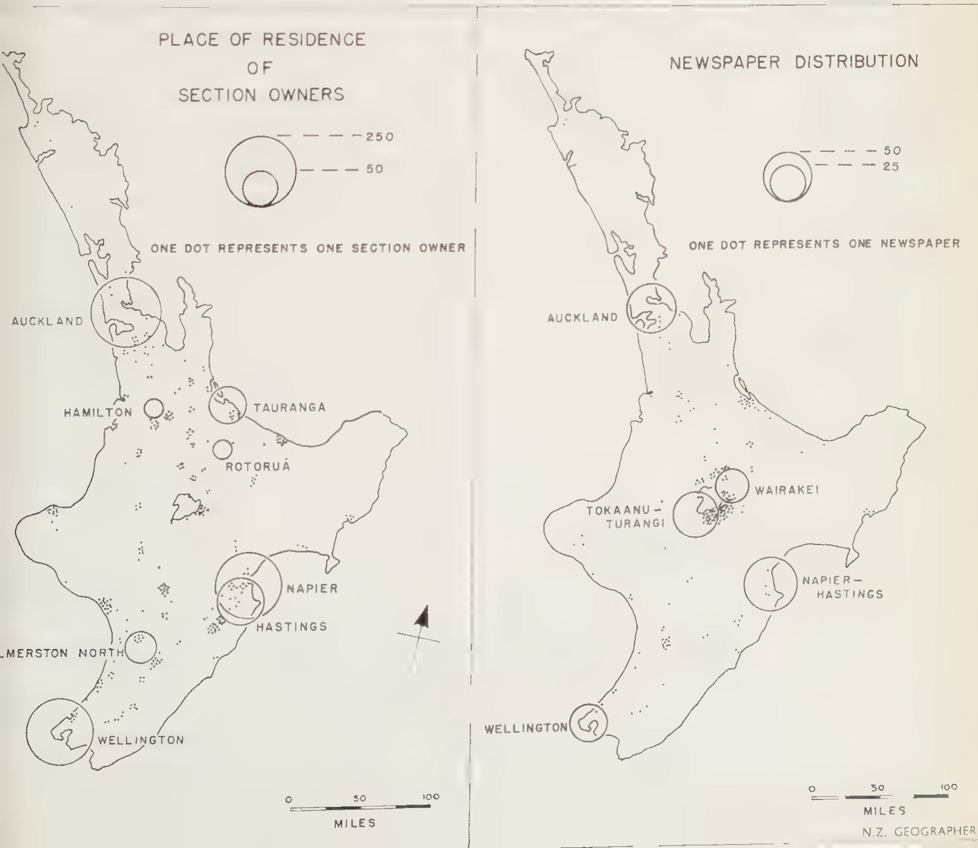
[7] This figure includes employees of the Ministry of Works, Department of Scientific and Industrial Research, and private contractors.

Town and Tributary Area

The function of Taupo as a servicing centre has not been of great importance in the past. Until recently, residents of the town itself were dependent on Napier or Rotorua for many services, especially in the professional sphere. In 1945, for example, there were no banks, accountancy firms or law firms in the town. Today, however, the situation is different and there are now three banks, five accounting firms and one

and 8. The place of residence of absentee section-owners and the circulation of the Taupo newspaper help to indicate where Taupo's regular visitors come from.



law firm. Expansion in the number and variety of retail businesses has been equally significant. Today there are sixty retail shops and seven garages within the borough, whereas in 1945 there were only ten shops and three garages. Of the shops present in 1945, no fewer than eight were concerned with the sale of foodstuffs, whereas today only forty percent are so engaged. The range of shops is now sufficient to supply virtually all normal requirements locally, and, as a result, the town is becoming less and less dependent on other centres for essential services. At the same time, the range of facilities and improved access are enabling Taupo to begin to compete with Rotorua and Taumarunui for the trade of the settlements outside the margin of its tributary area.

In the past eleven years, little change has taken place in the size of the area tributary to Taupo (*Figs.* 9 and 10). The tributary area may be delimited with relative ease, for the district is in the main a sparsely-populated area with a few small population nodes, each of which has fairly definite affinities with Taupo or some other town. Around the greater part of the fringe of the tributary area are fairly broad zones of poorly-roaded scrub, bush, or exotic-forest country. The major exceptions to this are the Broadlands area in the north, and the lakeside area towards Tokaanu in the south, and it is in these two districts that the influence of Taupo as a shopping and social centre is increasing.

Te Rangiita marks the southern boundary of the region which falls undisputably within the tributary area of Taupo. Meat and other foodstuffs are sent as far south as this each day by service car. The area to the south of Te Rangiita has affiliations with both Taupo and Taumarunui. The latter became the major centre for the Tokaanu district when the road across the Hauhungaroa Range was completed in the early 1940's and it has remained the shopping centre for many of the longer-established residents. The location in Taumarunui of the Maori Land Court and the district office of the Department of Maori Affairs helps to account for that town remaining the commercial centre for most of the Maori population of the Tokaanu district. But shorter distances, better roads and a good range of shops and services have encouraged the pakeha population, and particularly the more recently-settled residents who have no traditional ties with Taumarunui, to make Taupo their major shopping centre.

In 1945 the population of the tributary area[8] was 1,307 and the ratio of people in the tributary area to those in the town was approximately two to one. By 1956 the rural population had increased to 1,958, but the ratio had fallen to two to three. This change is an indication of the fact that in the last eleven years Taupo has not grown as a result of growth of population in its hinterland, but rather through the expansion of activities within the borough and because workers employed at Wairakei have been accommodated in the town. Nevertheless, the tributary area is now entering a new phase in which population is likely to grow more rapidly and the economic importance of the area to the town to increase correspondingly. Land on state-developed blocks is now ready to be settled and the breaking-in of new land is continuing. Private land at Broadlands and on the southern Kaingaroa Plains has also been developed recently. The utilisation of the exotic forests, and the opening of metal quarries to supply aggregate for the Wairakei project and for road construction, are also helping to attract population.

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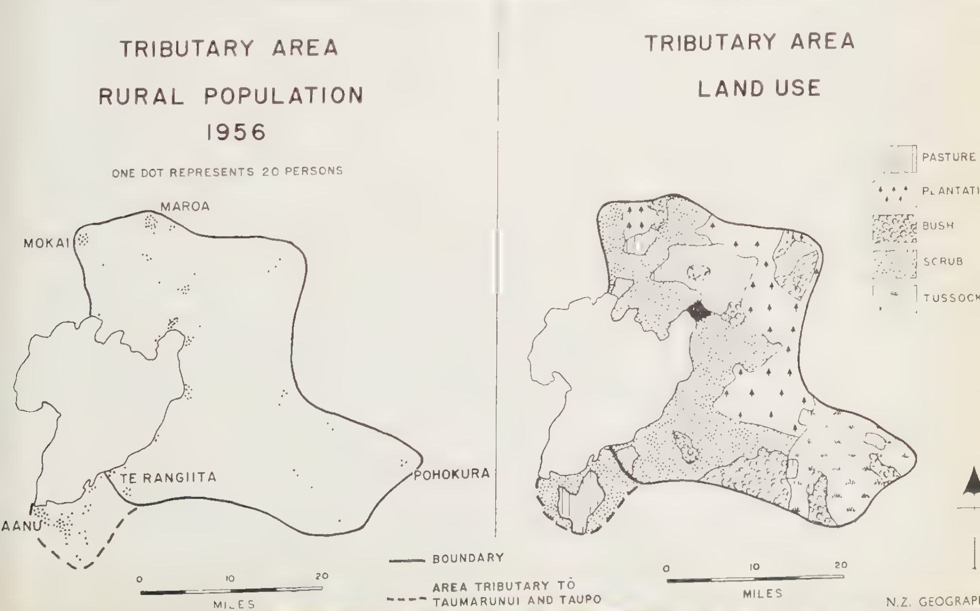
[8] This excludes that area which is tributary to both Taupo and Taumarunui as indicated in Figure 9.

Since the establishment of local government under a county commissioner, much has been done to improve the condition of county roads. Already, this has encouraged people from the southern Broadlands area to make Taupo their shopping centre. The fact that Taupo is now the administrative centre for the county will also help to increase its importance.

From the viewpoint of farmers, the absence of stock and station agents is the major deficiency in the services provided by Taupo. Once this service is available it is likely that increasing numbers of settlers from Broadlands will visit Taupo rather than travel the longer distance to Rotorua. It is also possible that, when these facilities are provided, Maori farmers from the Tokaanu area may transfer their custom from Taumarunui. Already many of these people visit Taupo at least once

s. 9 and 10. Population and land use of the area tributary to Taupo.



a week to take part in sport. With its central location, improved road links and increased range of commercial and other services, Taupo should be able to compete with Rotorua and Taumarunui with increasing success for the custom of the northern and southern fringes respectively of its present tributary area.

Conclusion

How long Taupo will continue to grow at its present rate depends largely on the progress of the Wairakei geothermal project. The major increase of construction workers may continue until early 1958, and although many of these will be housed at Wairakei, Taupo may have a population approaching 4,500 by then. A slackening in the rate of growth is then likely, together with a period of consolidation similar to that now being experienced in towns such as Rotorua and Tokoroa. Farming will play an increasing part in the economic life of the town, for development is well advanced on three of the blocks within ten miles of Taupo which will eventually provide sixty dairy and 108 sheep farms. A radial pattern of modern highways will provide easy access to the town for settlers on these blocks.

Rapid growth has brought many problems, and provision of power, water and sealed roads are among the more pressing. Already there is need for a second hydroelectric station to supplement that constructed by the borough in 1952. A water reticulation project is soon to be started, while a limited programme of street sealing was begun three years ago but needs to be extended. In all these undertakings, however, the inordinate mileage of roads presents a major difficulty and stresses the need for closer settlement, for implementation of the town plan already adopted, and for regulations to limit further subdivision. An additional problem resulting directly from the population increase is the provision of school facilities, and a separate high school and a second primary school are likely to be established in 1957.

With two well-established bases in the timber industry and the tourist trade, together with a hinterland with a growing population and considerable farming potential, the future of the town seems assured. The mushroom growth of the town during the past five years may be attributed to the Wairakei geothermal project, but by the time construction work is complete, nearby land at present under development should be settled. There will be little likelihood of any decline in urban population, and meanwhile few New Zealand towns of comparable size have four such sound bases for growth.

THE HUMAN GEOGRAPHY OF THE PACIFIC: A REVIEW

W. B. JOHNSTON

The romantic view of life and landscape in the South Sea islands has been transformed since the end of the Pacific war. This fundamental change in outlook is the result of increased study by a large number of topic and area specialists and the consequent mass of publications in a wide range of journals and major works. A more realistic appreciation of the human geography of the islands has been aided by increased facilities for travel and by numerous documentary films. Nevertheless it is largely through the medium of the written word that a sounder basis is being created for an understanding of the peculiar character of many Pacific island problems.

Much of the new information that has recently become available has been incorporated in major texts that have appeared over the last few years. As a general reference book the most valuable is the 1956 edition of *The Pacific Islands Year Book.*[1] In addition there is now available a broad and recent survey of the Pacific island world by Oliver,[2] and a description of island groups by a number of area specialists.[3] However, it is Cumberland's *Southwest Pacific*[4] which is most likely to be widely used in New Zealand schools and to be best known to the New Zealand public. A major disadvantage of this influential book was the lack, in the first two editions, of any references to sources to which the teacher, student and layman can go in order to extend their knowledge or keep abreast of recent developments. The third edition, however, adequately remedies this earlier deficiency. It is hoped that the present review of some recent publications will indicate for the tropical islands of the South Pacific the variety of valuable sources and will highlight a few of the present lines of investigation and recent results. At the same time no attempt has been made at a complete coverage, either areal or bibliographical.

An indication of the volume of literature available and active research work being carried on is to be found in the basic bibliographies. Indeed the number of bibliographies has warranted *A Bibliography of Bibliographies of the South Pacific*[5] which is the starting point in any search for information. To New Zealanders the most important of the bibliographies is Taylor's[6], which mainly covers physical and cultural anthropological literature of Polynesia, Melanesia and Micronesia, arranged by island group and topic. Research in land tenure, a major problem facing agricultural development, has been aided by an annotated bibliography. Current additions to literature in many fields of knowledge are listed in a number of journals, especially in the annual *Journal de la Société des Océanistes*[7] which contains a particularly exhaustive record.

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[1] R. W. Robson (Ed.): *The Pacific Islands Year Book,* 7th edition, Sydney, 1956.

[2] D. L. Oliver: *The Pacific Islands,* Cambridge, 1951, which is reviewed in *N.Z. Geographer,* Vol. 8, 1952, pp. 84-85.

[3] O. W. Freeman (Ed.): *Geography of the Pacific,* New York, 1951.

[4] K. B. Cumberland: *Southwest Pacific,* Christchurch, 1954, which is reviewed in *N.Z. Geographer,* Vol. 11, 1955, pp. 89-90.

[5] I. Leeson: *A Bibliography of Bibliographies of the South Pacific,* London, 1954.

[6] C. R. H. Taylor: *A Pacific Bibliography,* Wellington, 1951; H. M. Colonial Office: *Annotated Bibliography on Land Tenure, South East Asia and Pacific,* London, 1952; M. H. Sachet and F. R. Fosberg: 'Island Bibliographies', *Natl. Res. Council, Natl. Acad. Sci. Pub.* No. 335, 1955; H. Utinomi: *Bibliography of Micronesia,* Honolulu, 1952; F. M. Keesing: *Social Anthropology in Polynesia: A Review of Research,* Melbourne, 1953, which is reviewed in *N.Z. Geographer,* Vol. 10, 1954, pp. 98-100; A. P. Elkin: *Social Anthropology in Melanesia,* Melbourne, 1953, which is reviewed in *N.Z Geographer,* Vol. 10, 1954, pp. 194-196.

Changing Island Life

It is axiomatic that the island peoples are committed to a material and commercial civilisation and that no group or island is capable of being left alone and undisturbed. With the rise in the value of raw materials there has been an increase in the real income of the islanders and this is reflected in the shortage of labourers for work on plantations. The economic evolution from a stone age to a steel age has upset the ecological balance, and land deterioration has occurred in many areas.

The wider opportunities for individual distinction have been eagerly accepted on some islands, but despite the changes there remains a high degree of communal solidarity. Clear expressions of the feeling of 'wandering between two worlds, one dead, the other powerless to be born'[8] and the search for a solution are found in the 'Cargo Cults'[9] of New Guinea with their emphasis on economic prosperity, 'Marching Rule'[10] in the Solomons and its emphasis on political control, and the 'Naked Cult' and 'John Frum'[11] movements in the New Hebrides with their emphasis on new relationships between man and the spiritual world. Firth[12] has discussed these aspects and stated a second axiom: that economic changes are irrevocably associated with social and political developments. It is equally true that secure social and political progress is impossible without a firm economic basis.

Mander[13] elaborates this point of view in a major work in which two themes are emphasised. The first is that the frequent and complete destruction of the native way of life, and loss of *mana* are all too easily forgotten; the second is that, racially, men are equal in ability, character and personality. In the latter respect he is in full agreement with the UNESCO *Statement on Race*. In discussing recent trends in Western Samoa, Papua-New Guinea, Solomon Islands, Tonga, Fiji and New Hebrides he presents for each group, first, a view of the native way of life before the coming of the Europeans, and then traces developments up to 1950. This is a valuable background work in an historical sense and is based on a wide culling of literature. His discussion of modern Tonga, for instance, draws substantially on Simkin's article in an earlier number of this journal.[14]

A similar approach is adopted by Stanner[15] in his discussion of Samoa, Fiji and

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[7] Published in Paris. The 'Quarterly Reading List' of the *South Pacific Commission Quarterly Bulletin* (Noumea) is less extcusive but more readily available.

[8] Matthew Arnold ('Stanzas from the Grande Chartreuse', 1855) quoted *in* O. H. K. Spate: 'Changing Native Agriculture in New Guinea', *Geog. Rev.*, Vol. 43, 1953, pp. 151-172.

[9] See, for example, R. M. Berndt: 'A Cargo Cult Movement in the Eastern Central Highlands of New Guinea', *Oceania*, Vol. 23, 1952, pp. 40-65, 137-158; and *ibid.*, Vol. 24, 1953, pp. 202-234.

[10] See, for example, C. H. Allan: 'Marching Rule: A Nativistic Cult of the British Solomon Islands', *Corona*, Vol. 3, 1951, pp. 93-100.

[11] See, for example, J. G. Miller: 'Naked Cult in Central West Santo', *Journ. Polyn. Soc.*, Vol. 57, 1948, pp. 330-341.

[12] R. W. Firth: 'Social Changes in the Western Pacific', *S.P.C. Quart. Bull.*, Vol. 3, No. 4, 1953, pp. 24-28.

[13] L. A. Mander: *Some Dependent Peoples of the South Pacific*, New York, 1954.

[14] C. G. F. Simkin: 'Modern Tonga', *N.Z. Geographer*, Vol. 1, No. 2, 1945, pp. 99-118

[15] W. E. H. Stanner: *The South Seas in Transition*, Sydney, 1953.

Papua-New Guinea. Belshaw[16] reviews New Caledonia in addition to the New Hebrides and Solomon Islands. The main value of the latter work, however, is in the new approach used. It is an analysis of society as it has developed in contact with a cash economy. The 'social economies of culture contact' in these groups are particularly interesting as the governments have made few attempts to improve the commercial position of the islanders and society is still at a primitive colonial stage.

The book, *Fijian Way of Life*,[17] deals largely with social customs and does not aim at an evaluation of the present position. However, the author does demonstrate the different Indian way of life in a country where one out of every three Indians is engaged in the sugar industry, and one out of every two is concerned with agriculture in general. Thus he underlines the strength of the Indian demand for land. The weakness of Fijians in trading is most apparent in that for every four country stores managed by Indians and two by Chinese, there is only one operated by a Fijian.

Some light is also shed on Fijian rural settlements and major regional variations in house type are discussed. These features are neither mapped nor fully explained but there is a clear indication of a valuable line of geographical investigation.[18]

FRENCH OCEANIA

The inauguration of the 'Coral Route' air service and the new shipping service offered by the Matson Line have opened French Oceania, and Tahiti in particular, to New Zealand travellers. Within the South Pacific this area is one about which little is known to English readers and over which there persists a highly romantic aura.[19] The focus of the whole region is Tahiti where French influence is most apparent. On this island lives fifty percent of the total population of French Oceania and here, where external contacts are greatest, change has been most marked. In addition the close administrative and economic ties with France have been irksome and a frequent cause of disputes.[20]

An outstanding feature of the human geography of French Oceania is the variation from island to island of the demographic recovery after the early rapid and at times violent decreases in population. Poirier[21] has reviewed the general position and, in addition to the common causes of population change in the South Pacific, he notes the impact of Chinese colonisation which threatens to alter completely French Polynesia and to lead to racial conflict. Already the question of reserving certain islands against Chinese immigration is seriously posed. This study, along with that of Raoul[22] provides a valuable survey of the demographic situation.

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[16] C. S. Belshaw: *Changing Melanesia*, London, 1954.

[17] G. K. Roth: *Fijian Way of Life*, London, 1953.

[18] See, for example, W. B. Johnston: 'The Cook Islands: Settlement in an Island Group of the South-West Pacific', *Mal. Journ. Trop. Geog.*, Vol. 5, 1955, pp. 1-11.

[19] French Oceania consists of the Society Islands which are divided into the Windward (including Tahiti) and Leeward groups, Tuamotu Islands, Marquesas Islands, Mangareva (formerly Gambier) and Austral Islands (including Rapa). Cumberland excludes all these island groups from New Zealand's 'Pacific Island Neighbourhood', but he emphasises that with improved transport facilities 'it may soon be necessary to extend [its] boundaries . . . in this direction'. New Caledonia is however included in Australia's 'Pacific Island Neighbourhood'. (Cumberland: *op. cit.*, pp. 165-171 and p. 319.)

[20] N. Robson: 'French Oceania takes Stock', *Pacific Affairs*, Vol. 26, No. 1, 1953, pp. 24-43.

[21] J. Poirier: 'L'évolution récente des sociétés polynésiennes', *Journ. Soc. des Océanistes*, Tome 6, 1950, pp. 67-86.

[22] T. Raoul: 'Etude démographique sur les établissements français de l'Océanie de Cook au recensement des 17/18 Septembre 1951', *Bull. Soc. Études Océanniennes*, Tome 9, 1953, pp. 6-30.

The 1951 census of French Oceania gave a population of nearly 63,000, which represented an increase of 12.5 percent since 1946. The island of Tahiti with a population of 30,500 showed an increase of 25 percent over the same five years. This island has the most complete records of population numbers but the early estimates vary greatly in totals and in accuracy. Two estimates made by Cook were of 240,000 in 1769 and 70,000 in 1776. The estimate of 16,000 by English missionaries in 1807 is more reliable. The first census, apart from those of missionaries, was in 1848 when the island of Tahiti had a population of 8,500. The decline in population continued until the 'sixties with, thereafter, a continuous increase. Since 1900 most of the increase has been in the chief town of Papeete which contained over 15,000 persons in 1951.

The slower recovery and rate of growth in population of the outer islands of French Oceania are most striking. Whereas between 1911 and 1951 Tahiti increased by 161 per 100 (Papeete 245 per 100), the ratio for Moorea (also in the Windward Islands, was only 88 per 100; for the Leeward Islands, 69 per 100; for the Tuamotu Islands) 43 per 100; and for the Marquesas Islands, 6 per 100. The very low rate of increase in the Marquesas Islands is partly a result of emigration, but is largely the outcome of an exceptionally slow recovery from the ravages that caused the marked decline of the previous century. In 1769 Cook gave a very high and unreliable estimate of 100,000 for the Marquesas Islands. Two more accurate estimates gave 20,000 at about 1840. The census total of 1911 was only 3,116 and this figure declined further to the nadir of 2,400 in 1936. Thereafter there has been a gradual upward trend to reach over 3,200 in 1951. This late recovery in population is probably unique for a Polynesian island group.

The origin of the Chinese element, which is largely concentrated in the Society Islands, dates from 1864 when authority was given to obtain 1,200 coolies as labourers on the cotton plantations. By 1911 there were still less than a thousand but, in common with the history of alien elements in most Pacific territories, they have recently shown a rapid rate of increase. By 1926 the total had jumped to 4,000 and in 1951 there were nearly 7,000. This represents an increase from 1911 to 1951 of over 600 per 100. As Raoul points out, the rate of increase is actually much faster because significant numbers returned to China during the period. The importance of the Chinese element in the plural society lies not only in total numbers but, as elsewhere, in their role as controllers of general commerce.

NEW CALEDONIA

New Caledonia provides one of the most striking illustrations in the Pacific of the role of Western control and political policy in changing the human geography of an island country.[23] French sovereignty was proclaimed over New Caledonia in 1853, which makes it one of the oldest colonial areas in the Pacific. This long period (for the Pacific) of Western control is a basic factor. Another is the policy of French colonisation and the early period of penal settlement. A third important feature is the attraction of mineral exploitation, especially of nickel, which was particularly potent between 1870 and 1910, and which still persists.[24]

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[23] See the valuable series of articles collected in the number of the *Journal de la Société des Océanistes* commemorating the centenary of French sovereignty. See 'Un Siècle d'Acculturation en Nouvelle Calédonie', *Journ. Soc. Océanistes*, Tome 9, 1953.

The sharp decline in native population began to appear in the 1850's and ended near the turn of the century.[25] The years from 1900 to 1926 form a period of quasi-stagnation. However, since 1926 there has been a slow but continuing increase. From a total of 50,000-60,000 in 1850, the native population of New Caledonia and its territories[26] reached a low of 27,000 in 1920 to rise to 33,000 in 1951, a total which barely equals that of 1891. Amongst the causes put forward by Métais for the depopulation are new diseases introduced late in the nineteenth century. Pneumonia was severe and the earliest; beriberi was brought in by Annamite labourers in 1891; and in 1865 the Chinese introduced leprosy which was particularly deadly. The present slow rate of increase is related not only to high infant mortality but also to the loss of the familiar way of life and the restriction of natives to reserves. The 33,000 natives and 22,000 Europeans, largely of French extraction, are the two dominant elements in the population of New Caledonia and its territories, although there are several thousand Asiatics.

The changes in the site and form of native settlements have been as striking as the population trends. As Avias[27] notes, the physical and climatic conditions have not changed, apart from increasing dryness in some areas where the water table has been lowered. On the other hand the economic and social environments have been profoundly altered.

The pre-European village sites were chosen in relation to three key features—the availability of water, an elevated position for defence, and an adjacent area for the cultivation of food crops. The coasts and alluvial plains were the most densely populated regions although there were numerous villages in interior valleys and along the foothills. The areas of peridotite and serpentine were left unsettled as they were too dry and barren. However, the margins of these massifs were second to the lowlands in population density. Here were schist rocks mixed with volcanic and calcareous elements. The fertile slopes and valleys provided arable land; abundant water was available and, because of the high elevation, gravity irrigation was possible; in addition, the caves of karst areas provided shelter and a refuge.

Today the distribution of the native population is vastly different. Their rural domain is limited to reserves which are concentrated on the poorer east coast. This concentration left the more favourable west coast open for European colonists. Further displacement of peoples and land confiscation followed the suppression of native uprisings, particularly after 1878. However, not all the native people are rural dwellers. In New Caledonia, as on other islands in the South Pacific,[28] the drift of islanders to the major urban centres is an important feature which has been accentuated by the substantial numbers who have abandoned tribal life. Elsewhere the religious missions have attracted village settlements. Diseases have often caused villages to shift, while others have moved as their sources of water have dried up or salt water has penetrated into coastal wells.

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[24] J. P. Faivre: 'Vue Générale de l'Histoire Calédonienne', *ibid.*, pp. 9-23.

[25] P. Métais: 'Démographie des Néo-Calédoniens', *ibid.*, pp. 99-128.

[26] Principally the Loyalty Islands.

[27] J. Avias: 'L'évolution de l'habitat indigène en Nouvelle-Calédonie', *ibid.*, pp. 129-150.

[28] See, for example, 'Enquête sur la situation sociale des indigènes à Noumea', *Études Mélanésiennes*, Vol. 3, 1951, pp. 83-122; G. Taylor: 'Fiji: A Study in Tropical Settlements', *Econ. Geog.*, Vol. 27, 1951, pp. 148-162; V. D. Stace: *An Economic Survey of Western Samoa*, Noumea, 1955, pp. 71-88 (mimeographed). Stace's report is now published as *S.P.C. Technical Paper No. 91*.

The type of dwelling has also altered. The traditional house—the 'case en ruche' —was like a beehive, circular with a conical roof. This style has been progressively abandoned as a result of the decline in collective organisation of village building and, above all, of the desire of the native to live like the European colonist in a rectangular cob house. Indeed this trend has been encouraged by the administration, although the native usually lacks the economic resources to provide windows and doors. Thus the contemporary home is neither as suitable nor as healthy as the traditional dwelling.

POPULATION CHANGES

The causes of the staggering depopulation of the Pacific islands have been studied only spasmodically. As Belshaw[29] notes, the bulk of the studies were made in the decades of 1920 and 1930 when attention was paid at first to medical aspects and later to psychological distress—'la grande misère psychologique'. Recent evidence confirms his conclusion that decline ceases as violence lessens, diseases are controlled and a degree of immunity is acquired. Mills[30] has recently discussed the problem with reference to Futuna Island in the New Hebrides, an island group which supplied involuntarily much of the slave traffic in the South Pacific during the late nineteenth century.[31]

Population statistics for Futuna Island cover an unusually long period, and record with considerable accuracy the changes on a small volcanic island. The figures show a long period of decline, from at least 1871 to 1926, and, thereafter, a slow recovery. Mills lists twenty-five reasons that have been advanced at various times to account for depopulation in general. Only four are considered of major importance. First, introduced diseases, which are related to the second factor, namely, recruitment of slave labour. Between October 1866 and June 1871 at least 107 males and six females were taken off the island. Only twenty-five are known to have returned; and those that did return were often carriers of new diseases. There is a correlation between the end of the sharp fall in population and the cessation of the importation of native labour into Australia in 1901. Also related to the slave trade is the unfavourable sex ratio. In 1926 there were still only 92 males to every 100 females on Futuna Island and a balance was not achieved until 1933. Since then the figure per 100 females has varied between 110 and 120.

The third cause advanced is lack of hygiene and tendency for islanders to crowd together in dwellings, thereby facilitating the spread of diseases.[32] For example, more than a hundred persons died of dysentery in 1892. Mills ranks as the fourth factor indigenous diseases which lowered the strength of natives. It is suggested therefore that in the case of one island at least the decline in population was halted by the abolition of the slave trade whilst the present increase is primarily a result of the acquisition of a degree of resistance to diseases.

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[29] Belshaw: *op. cit.*, pp. 90–97.

[30] A. R. Mills: 'A Health Survey of Futuna Island', *S.P.C. Quart. Bull.*, Vol. 4, No. 1, 1954, pp. 26–28.

[31] An illuminating survey is given by Mander: *op. cit.*, pp. 460–483.

[32] This aspect is elaborated by E. Massal: 'Village Hygiene', *S.P.C. Quart. Bull.* Vol. 5, No. 1, 1955, pp. 2–5.

Malaria has not been an active agent on Futuna Island as it lies east of Buxton's Line of 170 degrees east which marks the eastward limit of malaria in the Pacific.[33] To the west of the line, however, the disease lowers the efficiency of native labour and the health of the population, and accounts to a large extent for the high infant mortality.

Black[34] has elsewhere discussed some of the geographical consequences of malaria. He points out that, although the altitudinal limits of the disease in New Guinea are uncertain, it is known that malaria has been the cause of some tribes completely abandoning fertile valleys and retreating to mountain slopes. The reasons for the limit of malaria at Buxton's Line are unknown; nor is an explanation available of why islands close together but on either side of the line are not both malaria-infested. There appears to be no climatological correlation. It is hoped that the detailed investigations now being made will shed further light on this highly important element. In the meantime the strictest of quarantine conditions must continue on those favoured islands to the east where the tackling of the mosquito problem has achieved notable results—Fiji, Rarotonga and Tahiti.[35]

Food Problems

Under the impact of a commercial economy the islanders have increasingly sought the means of adding to their sources of income. At the same time it must be fully realised that the native is imbued neither with the same commercial incentives as the European planter and trader, nor with the same social aims of raising his level of living.[36]

Ever since the first traders sought the products of the islands and adjoining seas, and displayed the material goods of a western civilisation, the pre-European economy with its self-sufficient and subsistence basis has been unable to meet the new desires of the local people. Agricultural production has increasingly tended to focus on commodities for sale and less on food for domestic consumption. Formerly the direct sale of one's labour was a prime source of income, but the growing trend is towards cash cropping.

The production of cash crops and the consumption of imported foods have resulted in major changes in diet.[37] In the atolls of the Tuamotu Group there is an almost complete dependence on new foods; for example, flour, sugar, and tinned meats.[38] A similar tendency has been noted in a wide range of islands. A recent and detailed report discusses this trend among the peoples of the Milne Bay area and off-lying islands of southeast Papua.[39]

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[33] R. H. Black: 'Malaria in the South-West Pacific', *S.P.C. Tech. Paper No. 81*, 1955.

[34] *idem:* 'The Geographical Distribution of Malaria in the South-West Pacific', *Austr. Geogr.*, Vol. 6, 1955, pp. 32-35. See also P. Gourou: *The Tropical World*, translated by E. D. Laborde, London, 1953, pp. 6-12. The latter work deals largely with humid, tropical regions outside the Pacific and provides an admirable and broad base against which to study the Pacific islands with their somewhat similar problems.

[35] Sir Philip Manson-Bahr: 'The Fight Against Filariasis in the Pacific', *Nature*, 28 February, 1953, pp. 369-371.

[36] Gourou: *op. cit.*, pp. 79-98. See also Stace: *op. cit.*, pp. 112-118.

[37] H. S. McKee: 'Cash Crops and Imported Foods in the South Pacific', *S.P.C. Quart. Bull.*, Vol. 6, No. 2, 1956, pp. 23-26.

[38] B. Danielson: 'Raroian Culture', *Atoll Res. Bull.*, No. 32, 1954.

[39] C. S. Belshaw: 'In Search of Wealth', *American Anthropologist*, Vol. 57, No. 1, Pt. 2, 1955.

The increase in cash cropping has also been accompanied by extended cultivation of food crops that are easily grown.[40] These crops are commonly those that can be stored in the ground or gathered when required rather than those harvested at a specific season. A strong case has been advanced for greater encouragement of subsistence agriculture as a buffer against a fall in export prices and as a basis for a better diet than that usually provided by imported foods or newly-favoured crops.[41]

Massal and Barrau[42] have collaborated in a valuable series of illustrated articles on Pacific subsistence crops in which they discuss botanical characteristics, methods of cultivation, nutritional values, and roles in the island economies. They emphasise the growing tendency of *Xanthosoma* (*tarua* of Tahiti and Rarotonga) to replace true taro (*Colocasia*) because the former is easier to cultivate and can be stored in the ground. This crop has spread widely, although it was not introduced into most islands until the nineteenth century. Two other crops which are increasing rapidly in significance are the sweet potato and cassava (*manioc* or *manihot*). The first of these is worthy of continued expansion. It gives large yields, matures quickly, is easy to grow, and has a high food value. Thus it allows more time for other activities without a decrease in dietary properties. Cassava has the most unbalanced protein content of all the staples of the islands. It was introduced into many Pacific islands probably in the first half of last century and has spread extensively on to good as well as poor soils. The ability to grow well on poor soils has encouraged its expansion on many of the less-favoured islands. However, on Aitutaki in the Cook Group, and elsewhere, it has replaced taro.

New Guinea

Agricultural patterns in the islands are remarkable. With respect to Melanesia in general, and to New Guinea in particular, Barrau has described the diversity as a 'living museum of agricultural geography'.[43] The quoted examples range from the sago gatherers of the coast to the Marind seasonal migrators of Netherlands New Guinea. These people cultivate their crops on the coast in the wet season and move into the interior to hunt during the dry months. The pre-European systems appear to have been well adapted to the physical environment. This remains true for some of the modern counterparts; for example, each village in the Markham Valley shows a zonal pattern. On the gravel alluvial flats that are subject to flooding the chief crop is bananas; on the grassy, intermediate hill slopes taros and yams are cultivated; whilst within the tropical rainforest of the higher slopes shifting cultivation (*ladang*) is the rule. The detailed pattern has been generalised by Barrau for New Guinea as a whole.[44]

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[40] E. Massal and J. Barrau: 'A Survey of Subsistence Problems in the South Pacific', *S.P.C. Quart. Bull.*, Vol. 6, No. 2, 1956, pp. 34-35.

[41] McKee: *op. cit.;* E. Massal: 'Dietary and Nutritional Problems in the South Pacific', *S.P.C. Tech. Paper No. 59,* 1954.

[42] E. Massal and J. Barrau: 'Pacific Subsistence Crops' series; 'Breadfruit', *S.P.C. Quart. Bull.*, Vol. 4, No. 4, 1954, pp. 24-26; 'Sago', *ibid.*, Vol. 5, No. 1, 1955, pp. 15-17; 'Taros', *ibid.*, Vol. 5, No. 2, 1955, pp. 17-21; 'Sweet Potato', *ibid.*, Vol. 5, No. 3, 1955, pp. 10-13; 'Cassava', *ibid.*, Vol. 5, No. 4, 1955, pp. 15-18; 'The Banana', *ibid.*, Vol. 6, No. 1, 1956, pp. 10-12; 'The Coconut', *ibid.*, Vol. 6, No. 2, 1956, pp. 10-12. See also S. Malcolm and J. Barrau: 'Yams', *ibid.*, Vol. 4, No. 3, 1954, pp. 28-31; J. C. Gerlach: 'Cultivation of the Banana', *ibid.*, Vol. 6, No. 1, 1956, pp. 32-37.

[43] J. Barrau: 'Traditional Subsistence Economy and Agricultural Progress in Melanesia', *ibid.* Vol. 4, No. 3, 1954, pp. 2-7.

Within New Guinea the Mekeo country lying approximately a hundred miles west of Port Moresby is a centre of experiment. In this area dry rice, originally introduced by the missions at the beginning of the twentieth century, has become the key crop in a fully mechanised agricultural scheme. Over 15,000 tons of rice are required annually to feed plantation labourers in New Guinea, for native food crops are too bulky to transport any distance. A number of attempts are being made to increase rice production in New Guinea, and the Mekeo scheme is one of the most progressive as well as one of the most controversial. Spate doubts whether the small area involved is an economic proposition. Since he wrote, the scheme has been altered as experience showed weaknesses.[45] The 'Rural Progress Societies' which were the agricultural, commercial and administrative organisations of the collectivist approach have been replaced by native co-operatives which restrict their activities to buying, processing and marketing. The people are now free to choose their own social units for working. Mechanisation is more limited; mechanical cultivating, and not harvesting as formerly, is provided only if wanted. Harvesting by hand allows other crops to be grown between rows of dry rice and, in this way, is more in accord with the familiar system of garden cultivation.

The revolution from digging stick to multipurpose machine is not limited to the Mekeo people. Similar experiments are reported from the Madang district where a large communal rice garden has been established and the region opened up by new roads.[46] The results of these and other experiments are noteworthy since the tremendous adjustment required of local societies is significant for all the Pacific islands, and indeed for many areas of the world where similar cultural and economic conditions exist.

Some of the land-use problems in New Guinea have been outlined by Conroy.[47] One of the most important is the extension of useless grassland where burning is practised by natives for hunting purposes. In the extensive middle Markham and Ramu Valleys uncontrolled burning is accompanied by accelerated erosion, flooding and silting. There may be a loss overnight of a hundred or more acres of good garden land. Furthermore, large alluvial fans are being built from the increased material available to tributary streams. At the same time progressive lateralisation is encouraged.

In the higher rainfall areas along the coast, as on the Huon Gulf and Madang littorals, extensive burning is impossible, but reports have been made of clearings on steep slopes which have resulted in large-scale land slides.[48] Spate[49] notes another disturbance of the ecological balance, this time in the populous Central Highlands. The introduction of the steel axe has made possible the complete removal of forest cover. Increased runoff and erosion have resulted in impeded drainage of lower land which, thereby, has been lost to cultivation. The population is moving from the useless swamp land to steeper ridges, a movement that is intensified by population growth and by the increased demand for more cropland.

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[44] See also Spate: *op. cit.* for reference to the Gazelle Peninsula.

[45] J. McAuley: 'Economic Development among the Mekeo', *S.P.C. Quart. Bull.*, Vol. 6, No. 1, 1956, pp. 30-31.

[46] R. N. Hancock: 'Roads, Rice and Rural Progress in the Madang District of New Guinea', *ibid.*, Vol. 4, No. 4, 1954, pp. 18-22.

[47] W. L. Conroy: 'Notes on Some Land Use Problems in Papua and New Guinea', *Austr. Geogr.*, Vol. 6, 1953, pp. 25-30.

[48] H. I. Hogbin: *Transformation Scene, The Changing Culture of a New Guinea Village*, London, 1951, pp. 61-74.

[49] Spate: *op. cit.*

PROBLEMS OF THE COPRA INDUSTRY

Conroy mentions two other problems that are of wider application. The first is the lack of balance between crops and livestock in the agricultural economy;[50] the second is the concentration of commercial agriculture on copra production.

A recent survey[51] of the copra industry emphasises the economic dependence of the territory on copra which, since 1945, has constituted about sixty percent of the exports of Papua-New Guinea. Gold is the only other important export. Native production provides barely twenty percent of the export total, and, therefore, the plantations are of major importance. More than ninety percent of their production comes off estates which are over 400 acres in size, the largest of which covers almost 5,000 acres. The principal problems faced by the planters are threefold: first, the old age of palms, for half are in middle life or older, and the slow rate of replanting which barely maintains the present position; second, the irregular postwar transport; and third, the high labour costs which amount to over fifty percent of gross costs, and the lowering of which depends largely on increased local and regional production of food crops for the labourers—hence the significance of schemes for increased rice production.

The copra industry is of basic importance to the South Pacific as it provides some two-fifths of the total export revenue of the islands.[52] The rehabilitation of war-devastated groves is one problem; another is to increase plantings to meet the needs of growing populations;[53] and a third is the destruction wrought by the rhinoceros beetle.[54] The beetle occurs in many areas and islands from India to Vavau in the Tongan group. It has been in Samoa since 1910, New Britain and New Ireland since 1942, Vavau since 1952, and Viti Levu since 1953. At Rabaul and in the port areas of Apia and Pago Pago, Dumbleton regards the pest as virtually uncontrollable. Its recent introduction into Vavau and Viti Levu re-emphasises the need for stricter quarantine conditions.

In Papua-New Guinea the Australian Government considers that there is ample land available for the coastal natives, and it aims 'to make available suitable [coconut] land for settlers and to construct access to that land'.[55] Within the Central Highlands European settlement is also being encouraged with coffee planting as a basis. The high prices on the Sydney market make it economic to fly out the crop. The recent establishment of an experimental agricultural station in the Highlands is a reflection of this settlement. However, the experimental station has also been responsible for introducing new crops into native gardens. For example, the tree tomato is now virtually a staple in some areas, while cereals (especially maize), beans and root crops have been widely distributed. New and heavier-yielding varieties of sweet potato, brought from America and Australia, have proved successful innovations.[56]

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[50] R. B. Kelly: 'Animal Production in the South Pacific', *S.P.C. Quart. Bull.*, Vol. 3, No. 2, 1953, pp. 9–10; Gourou: *op. cit.*, pp. 53–64.

[51] 'An Economic and Cost Survey of the Copra Industry in the Territory of Papua and New Guinea', *Bureau of Agric. Econs. Bull. No. 9*, Canberra, 1953.

[52] 'Copra Production Costs in Papua and New Guinea: Review of Survey', *S.P.C. Quart. Bull.*, Vol. 3, No. 4, 1953, pp. 7–8.

[53] W. V. D. Pieris: 'Rehabilitating the Coconut Industry', *ibid.*, Vol. 4, No. 1, 1954, pp. 2–5.

[54] L. J. Dumbleton: 'Rhinoceros Beetle Quarantine and Control Problems', *ibid.*, Vol. 3, No. 3, 1953, pp. 2–4.

[55] 'An Economic and Cost Survey of the Copra Industry . . .', *op. cit.*

Thus, although New Guinea may with justification be called a 'living museum of agricultural geography', it is also an 'agricultural laboratory'.

An Agricultural Geography of New Caledonia

The spectacular periods of mineral exploitation in New Caledonia have led to neglect of the basic reason for French colonisation—that of agriculture—and imposed a distinct handicap on stable economic development. Barrau has analysed the agricultural geography of the island in detail and proposed several solutions to particular problems.[57]

The main limiting factors of a physical nature are the rugged interior, the irregularity of precipitation associated with a marked dry season in the spring months from October to December, and the 1,200,000 acres of ferruginous soils and soils derived from serpentine rocks which support the distinctive vegetation of the 'maquis de serpentines'. The alluvial soils which are the most valuable amount to less than 250,000 acres out of a total land area of four million.

The first European settlers introduced two forms of agriculture: small-scale mixed farming on a family basis and extensive grazing. As Barrau points out, the settlers have remained too attached to mid-latitudinal systems of agriculture, and this is illustrated by frequent discussions of the possibilities of wheat production. Further, the rapid decline in crop yields after the first harvests showed the falsity of belief in the fertility of tropical soils and led to disillusionment. Thus an outstanding feature has been the instability of agriculture arising from the initial waves of enthusiasm and final discouragement. The failure of speculations with sugar cane, rubber, cotton, wheat and other crops was followed by rural exodus which, in turn, was accentuated by the periods of mineral booms. The abandoned land has been invaded by weeds, especially lantana, and only rarely have the areas been turned into pasture land.[58]

Native land use is divided into two types. The first is native subsistence agriculture based on traditional crops such as yams and taro, and on introduced crops including manioc, sweet potato, maize and bananas. Commercial agriculture is the second type. Native production accounts for 5,000 acres, or two-thirds, of the total coconut land, and 6,000 acres, or more than two-fifths, of the total coffee area.

European agriculture is everywhere commercial in character. First there are the perennial crops, of which coffee[59] and coconut are the most important. Some 7,500 acres of coffee are grown by Europeans on holdings averaging seventeen acres in size, and the crop is integrated with the small, family mixed farm. Many of the coffee lands are, however, neglected, abandoned, or exploited by Indonesians or natives within a share-cropping system. Second, a variety of annual crops is grown on the mixed farm; for example, cereals, potatoes and beans.

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[56] 'Crop Production in Papua and New Guinea', *S.P.C. Quart. Bull.*, Vol. 3, No. 2, 1953, pp. 20–21.

[57] J. Barrau: 'L'utilisation agricole and pastorale des terres de la Nouvelle-Calédonie', *Études Mélanésiennes,* No. 7, 1953, pp. 3–22.

[58] A. Guillaumin: 'L'évolution de la flore néo-calédonienne', pp. 79–85 in 'Un siècle d'acculturation en Nouvelle-Calédonie 1853–1953', *op. cit.*

[59] D. H. Urquhart: 'Coffee Growing in New Caledonia', *S.P.C. Tech. Paper No. 38,* 1953.

Within the prevailing physical conditions good returns are possible from all crops grown on the mixed farm, but a number of human factors have been detrimental—the small size and extreme fragmentation of holdings, the highly-individualistic outlook and disinclination to work in co-operatives, and the postwar labour shortage which has led to an excessive demand for machinery as reflected in the ratio of tractors to the area cultivated annually (one tractor to thirty-seven acres). Another fundamental factor is the deep division between the large-scale grazier and the small-scale farmer.

Pastoral land use is founded on the extensive Australian system, with fattening before slaughter on the better pasture land of the alluvial plains. About two-fifths of the island is used for grazing some 92,000 cattle. For an extensive system this gives a high cattle density which is primarily responsible for overgrazing, pasture deterioration and accelerated erosion. Numerous and unsuccessful attempts have been made to show pastoralists the benefits of a more intensive system of land use which would improve pastures, conserve topsoil, and prevent the spread of lantana, *Niaouli* and poor grasses.

A third agricultural element is market gardening by Indonesians and Vietnamese. These hardworking Asiatics are very active on the margins of the urban areas.

Barrau estimates that 250,000 acres, or one-sixteenth of the total area, is cultivable. At present no more than 37,000 acres are under cultivation. Stabilisation of agriculture is the prime aim to be followed by development, and for this Barrau sees the need for a new colonisation based upon four key features: first, the integration of grazing and cultivation with an end to the existing competition for land; second, the non-renewal of grazing leases where land has been misused; third, a programme of co-operative rural development; and last, but perhaps of first importance, the purchase of large properties and imposition of a graduated land tax to eliminate large and inefficient holdings.

The policy of French colonisation has required the removal of natives from the best land, and large numbers have been transferred from the productive west to the less desirable east coast. As a result 2,000 Europeans hold more than 750,000 acres, of which they cultivate less than seven percent.[60] On the other hand the reserves total only 300,000 acres for the 21,000 natives in New Caledonia. Yet from this land the latter produced, in 1951, half of the coffee and eighty-five percent of the copra exported, and half of the maize sold on the local market. According to the 1946 census, fifty-one percent of the European rural land owners held only three percent of the conceded area, while three owners held over twenty-two percent. These figures point to the great division between the large-scale cattle grazier and the small-scale mixed farmer, a division which runs right through the history of land use in New Caledonia.

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[60] M-H. Lenormaud: 'L'évolution politique des autochtones de la Nouvelle-Calédonie', *in* 'Un Siècle d'Acculturation en Nouvelle-Calédonie 1853-1953', *op. cit.* pp. 245-300.

As Hartley[61] has pointed out, no extensive, co-ordinated attempt has been made to discover and introduce plants of economic value from analogous regions outside the Pacific. There is no major botanical garden within the region and only in New Guinea and Fiji have well-planned efforts been made to extend the initial introductions of experimental stations. Pepper[62], bamboo[63] and soft fibres[64] are three items recently suggested. Attention has also been drawn to the promising prospects for the reafforestation of thousands of acres of fernland in the southern Cook Group.[65] Agricultural tools and techniques are capable of substantial improvement, as Barrau and others have suggested.[66] In Western Samoa for example, the sample agricultural survey of 1950 showed that, per village, the total number of axes, shovels, spades, grubbers and crowbars barely equals the number of able-bodied men.[67]

The conservation of fish resources and the implementation of modern ideas of fish farming offer the possibility of long-term increased production.[68] The introduction of fishpond culture into the Cook Islands and Fiji is equally important in view of its significance in the economy of Monsoon Asia.[69] Likewise the experiments in the rational use of pearl-oyster beds in French Oceania[70] may lead to farming of this sea resource rather than exploitation, hitherto a common feature in many island groups.

The prospects for industrial development are restricted by the small surplus population, few resources, limited markets and low purchasing power.[71] Apart from the encouragement of local handicrafts, the processing of agricultural products remains the main item and is generally limited to the first stage of manufacture. The range of activities is substantially wider in the larger islands of Melanesia but even here the rate of progress will be slow.[72] If New Zealand's experiment in its tropical 'province' of the Cook Islands is an indication, the vested interests of established firms in the administering countries are likely to oppose strongly any substantial developments which can compete in the home markets.[73]

Land Tenure—A Key Problem

The significance of land in native society has often been emphasised but the character and strength of communal ownership are less clearly understood. The attempts by administrators to put land titles on a regular basis have been only partially successful. By misinterpretation of native customs confusion has been heaped upon confusion. Gilson[74] has done a valuable service in explaining the origins of land policies in the Cook Islands.

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[61] W. Hartley: 'Plant Introduction and Exploration', *S.P.C. Quart. Bull.*, Vol. 4, No. 2, 1954, pp. 25-27.

[62] E. J. E. Lefort: 'Promising Cash Crop for Pacific Planters', *ibid.*, Vol. 6, No. 1, 1956, pp. 18-20.

[63] F. A. McClure: 'Bamboo Culture in the South Pacific', *ibid.*, pp. 38-40.

[64] E. J. E. Lefort: 'Soft Fibre Production in the South Pacific', *ibid.*, Vol. 4, No. 4, 1954, pp. 29-33.

[65] R. G. Thorby: 'Afforestation in the Cook Islands', *ibid.*, pp. 15-16.

[66] J. Barrau: 'Traditional Subsistence Economy and Agricultural Progress in Melanesia', *op. cit.*

[67] A. J. L. Catt: 'Western Samoa Agricultural Census', *S.P.C. Quart. Bull.*, Vol. 5, No. 4, 1955, pp. 32-33.

[68] H. Van Pel: 'Fisheries in the South Pacific', *ibid.*, Vol. 5, No. 3, 1955, pp. 2-4.

[69] *idem:* 'Pond Culture of Tilapia', *ibid.*, pp. 30-31.

[70] G. Ranson: 'Rehabilitation of Pearl Oyster Beds in French Oceania', *ibid.*, pp. 22-24.

[71] C. S. Belshaw: 'Small Scale Industry for the South Pacific', *S.P.C. Tech. Paper No. 89*, 1956.

[72] K. H. Danks: 'Industrial Activity in Selected Areas of the South Pacific', *ibid.*, *No. 90*, 1956.

[73] *The Press*, Christchurch, 21 and 25 June 1956.

[74] R. P. Gilson: 'The Foundations of Cook Islands Land Policy', *South Pacific*, Vol. 7, 1954, pp. 948-955; *idem:* 'The Background of New Zealand's Early Land Policy in Rarotonga', *Journ. Polyn. Soc.*, Vol. 64, 1955, pp. 267-280.

The result of attempts to rationalise land titles in these islands has been to leave the land-owning groups without a confirmed leader. The chief has been left without power either to limit the numbers in a land-owning group or to allocate land or to organise the use of land. Another important weakness has been the introduction of bilateral inheritance in place of the customary patrilineal descent. As a result of claims to ownership on both sides of the family, the size of land-owning groups has increased to surpass by far that of land-working groups. Although this does not mean fragmentation of land holdings, it does result in a fragmentation of ownership. Consequently the groups of co-owners have become so large that co-operation is difficult. Without either leadership or security of tenure the cultivation of long-term cash crops has been retarded.[75] The difficulty is illustrated in attempts to obtain the individual occupation rights that are necessary for participation in the citrus replanting scheme in the Cook Islands.[76]

The leasing of land to alien peoples has not been a problem in the Cook Islands, but in Fiji it is of major importance. Here the history of land tenure is one of rapidly-changing emphasis as the administration has realised the major character of problems posed by the sustained growth in Fijian and Indian populations.[77] Some 315,000 acres in 1953 were reported as leased by Fijians, mainly to Indians. The willingness to lease has often left the Fijians with insufficient land to maintain their increasing numbers. In the sugar-cane areas up to ninety percent of the available arable land has been leased. The scheme for the provision of land reserves in perpetuity for Fijians involves the resettlement of many Indian farmers upon the expiration of their leases.

Another pressing problem faces the Indian population. It is the limited land available in relation to the large number seeking farms. As a result, leased land is frequently subdivided and subleased at high rents. Under these conditions the moneylender has thrived and his power has been further increased by the credit demands arising out of costly social festivities; for example, wedding ceremonies.[78]

Social Geography

In the past a great deal of investigation and planning has been done in the realms of health, education and social affairs,but little attention has been given to economic development. Today production is barely keeping pace with increasing populations and opportunities for educated islanders are limited to clerical positions. The experiments in community development are therefore of absorbing interest, especially as they are akin to the traditional way of life.[79] Hayden[80] has written in extended form the story of the pilot project in community development on the island of Moturiki in the Fijian group. The island's population is less than 600 on an area of less than 3,000 acres. Most of the island is covered in reeds and low fern, and a third has been burnt over by shifting cultivators.

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[75] The problem, although somewhat different in character, is regarded as of major importance even in Western Samoa where native society has shown a remarkable ability to adapt its features to the demands of a commerical economy. See Stace, *op. cit.*, pp. 118–121.

[76] W. B. Johnston: 'Land, People and Progress in the Cook Islands', *Econ. Geog.*, Vol. 29, 1953, pp. 107–124; *idem:* 'The Citrus Industry of the Cook Islands', *N.Z. Geographer*, Vol. 7, No. 2, 1951, pp. 121–138.

[77] Roth: *op. cit.*, pp. 51–93; Mander: *op. cit.*, pp. 402–423; E. M. J. Campbell: 'Land and Population Problems in Fiji', *Geog. Journ.*, Vol. 118, 1952, pp. 477–482; R. Gatty: 'Fiji: Colony in Transition', *Pacific Affairs*, Vol. 26, 1953, pp. 118–130.

[78] A. C. Mayer: 'Aspects of Credit and Debt Among Fiji Indian Farmers', *Journ. Polyn. Soc.*, Vol. 64, 1955, pp. 442–449.

The project was carried through by a Fijian team assisted by the administration. The aim was to achieve a better living standard through active work by the community. After two years the Fijians who initiated the project left the island and a local committee took control. It was soon apparent that in some ways the project had not succeeded. Pigs were turned loose to resume their role as scavengers, rice was no longer planted, coconuts were again collected only when they dropped and the collecting schedules lapsed, and the two major copra growers established a rival trading co-operative. The pilot project was not a complete failure however. It highlighted the significance of the two key problems of leadership and finance. The latter is being faced in Fiji as a whole by the collection of a copra tax which is put into a development fund. The problem of leaderhip, however, remains critical.

The need for more than the 'three R's' in island education is pressing.[81] In the Cook Islands and elsewhere attempts are being made to provide educational services in character with the needs of community development schemes.[82] This is the case with the Nimboran Community Development Programme in Netherlands New Guinea[83] where the emphasis is on economic development in the belief that social cohesion will follow. The project is an attempt to provide employment for males who have been moving to the coastal town of Hollandia in order to earn money to pay the bride-price, to savour the new urban social life, and to fill in their ample leisure.

Political Geography

The human geography of the Pacific islands requires a knowledge of the policies of the administering powers.[84] The explanation of the areal patterns of agriculture and population in New Caledonia involves an appreciation of the role of the French policy of European colonisation. Likewise the 'aimless policy' of the administration in the Solomon Islands and the divided political responsibility in the New Hebrides are important reasons for the lack of development in both island groups.[85] In a thoughtful article, Davidson[86] sees 'colonialism' as indispensable in Fiji because

[79] V. D. Stace: 'The Pacific Islander and Modern Commerce', *S.P.C. Tech. Paper No. 54*, 1954; H. Belshaw: 'The Communities Approach to Economic Development', *ibid., No. 84*, 1955; 'The Purari Delta', *ibid., No. 35*, 1952. The community approach is recommended for Western Samoa by Stace: *op. cit.*, pp. 129–130.

[80] H. Hayden: *Moturiki, A Pilot Project in Community Development*, London, 1954.

[81] R. A. Derrick: *Vocational Training in the South Pacific*, London, 1952.

[82] P. F. Henderson: 'Further Education in the Cook Islands', *S.P.C. Tech. Paper No. 26*, 1952; J. Van Baal: 'Educating the Netherlands New Guinea Village', *S.P.C. Quart. Bull.*, Vol. 3, No. 3, 1953, pp. 18–22.

[83] *idem:* 'The Nimboran Community Development Project', *S.P.C. Tech. Paper No. 45*, 1953.

[84] J. McAuley: 'Paradoxes of Development in the South Pacific', *Pacific Affairs*, Vol. 27, 1954, pp. 138–149.

[85] Mander: *op. cit.*, pp. 311–349, 483–492; Belshaw: *Changing Melanesia, op. cit.*, pp. 15–24.

[86] J. W. Davidson: 'The Price of Political Dependency', *Australian Outlook*, Vol. 6, 1952, pp. 117–128.

democracy would bring Indian control. The 'backwater' character of Netherlands New Guinea is a consequence of the former dominant interest of the Dutch in the islands of the East Indies which provided greater and easier returns.[87] The rise of nationalism, which is displayed so well in Western Samoa, must be expected to continue and develop in other island groups. This is a major challenge of the present and of the future. And the political problems have economic and social implications.

The South Pacific Commission is playing a basic role in gathering the fundamental data and advising on the economic and social development of the myriad islands within its region.[88] The commission has received added impetus and importance by the decision of the United States Trust Territory of Micronesia to join the organisation. Special attention to the peculiar environment of the low islands of the Pacific is the function of the widespread and detailed Coral Atoll Programme of the Pacific Science Board.[89] A more restricted programme is the land-use survey of Western Samoa by the Department of Geography of Auckland University College whose complete report is keenly awaited.[90]

The new light being shed on the human geography of the South Pacific islands is of value in many fields. One application has been recently expressed by C. D. Rowley, Principal of the Australian School of Pacific Administration: '. . . problems must be seen in their historical and geographical setting because you cannot study administrative problems apart from the historical and geographical factors.'[91] And as new information becomes available and conditions change it is essential to re-evaluate.[92] In the Pacific world, as elsewhere on this earth, life and landscape are not static.

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[87] C. A. Fisher: 'West New Guinea in its Regional Setting', *Yearbook of World Affairs,* 1952, pp. 189-210.

[88] Of particular interest to New Zealand are the activities of the commission which apply directly to the dominion's insular responsibilities. See, for instance, Stace: *Economic Survey of Western Samoa, op. cit.*

[89] *Atoll Research Bulletin,* Washington, D.C. (mimeographed).

[90] Some background material is provided by L. Curry: 'The Physical Geography of Western Samoa', *N.Z. Geographer,* Vol. 11, No. 1, 1955, pp. 28-52.

[91] Quoted in Mander: *op. cit.,* p. 27.

[92] This has been shown recently by E. Beaglehole: 'Race Relations in the Pacific', *Intern. Soc. Sci. Bull.,* Vol. 2, 1950, pp. 489-496.

GEOGRAPHIC NOTEBOOK

IN THIS ISSUE. General economic expansion has been a marked characteristic of New Zealand since the war, and the burgeoning of manufacturing industries has been a conspicuous phase of that development. Development, however, has been sharply concentrated in particular parts of the dominion, and Mr. G. J. R. Linge, from the London School of Economics, has recently applied his training in both economics and geography to a study of the localisation of manufacturing, in which he has employed a variety of criteria to define more clearly the patterns of distribution of industry in New Zealand. Mr. Linge wrote this article whilst undertaking research on the industrial geography of metropolitan Auckland towards the Ph.D. degree at Auckland University College. He has recently been appointed as visiting assistant lecturer in geography at Canterbury University College.

One area in which economic growth is conspicuously rapid is the Taupo district in the heart of the North Island. Mr. R. G. Ward, junior lecturer in the Department of Geography at Auckland University College, has already contributed an article to the *New Zealand Geographer* on 'Land Development in the Taupo Country', and now presents an account of the recent development of the Borough of Taupo. It is an interesting and unusual story of a town and district, long neglected and little developed, but now moving rapidly forward, its development based on a unique combination of resources and activities.

If the modification of the vegetation in the Castle Hill Basin of Canterbury is less conspicuous than the spectacular developments near Taupo, it is nevertheless typical of much more extensive areas on the eastern glacis of the Southern Alps and in Central Otago. Mr. D. H. Relph, who took his M.Sc. degree at Canterbury University College in 1954 and is now teaching at Mt. Roskill Grammar School, Auckland, offers a detailed analysis of the vegetation of the basin and suggests measures to check deterioration too often apparent.

The problems of the scattered offshore islands of Northland are less widely appreciated and of much less economic significance, but Mr. G. R. Cochrane's article provides a geographic analysis of their varied characteristics and problems and an account of the extent of cultural modification which they have undergone. This statement is a brief synopsis of an M.A. thesis based on a detailed investigation conducted in 1953 and 1954. Mr. Cochrane, who must be one of a very small band of New Zealanders who have visited and conducted fieldwork on the many islands under review, took his M.A. degree at Auckland University College in 1954. He acted briefly as assistant lecturer in geography in the University of Otago in 1955 and is now on the staff of the Department of Geography in the University of Adelaide, South Australia. Islands scattered over the vast expanse of the South Pacific have been much more widely publicised than New Zealand's immediate offshore islands, and it is useful to have at hand a review of literature recently published on the dependent territories of the Southwest Pacific. Mr. W. B. Johnston, lecturer in geography at Canterbury University College, summarises a wealth of pertinent information, much of it rather inaccessible.

Other contributors to this issue include: Miss A. M. Gorrie of Auckland Teachers' College; Mrs. Joyce Bewley of Wellington; Miss Eileen Fairbairn of Christchurch and Miss Nancy Northcroft, Director of Planning, Christchurch Regional Planning

Authority; Mr. W. J. Brockie and Mr. R. G. Lister of the University of Otago; Mr. K. A. Hart of Rangitoto College, Auckland; Mr. A. D. Tweedie of Newcastle University College, New South Wales; Mr. J. S. Duncan of the University of Manchester; Dr. R. A. Falla, Director of the Dominion Museum, Wellington; Mr. J. W. Parham, Department of Agriculture, Suva, Fiji; and the Editorial staff.

GEOGRAPHICAL CONGRESS IN BRAZIL. The Eighteenth Congress of the International Geographical Union was held in Rio de Janeiro, Brazil, in August 1956. Amongst geographers from thirty-eight countries were three representatives of the New Zealand Geographical Society. At meetings of the thirteen sections, sometimes held simultaneously, papers were presented in English and French, the two official languages, and in Portuguese, Spanish, German and Italian. Even the most diligent members could personally follow only a fraction of the subject, but summaries were provided and in due time the final report of the congress will be available to make up this deficiency.

The interest of visiting geographers in Brazil was increased by the inclusion of a symposium on the problem of grasslands in tropical regions, and by lectures on 'The Settlement of Brazil', 'Mineral Resources', and 'Power Problems in Brazil'. There were also two excellent exhibitions of maps, atlases and geographical literature, one relating to Brazil, the other to the rest of the world.

During the four-year periods between congresses, commissions produce reports on a variety of subjects proposed by the congress. The reports of the commissions on the Teaching of Geography in Schools, and the Inventory of World Land Use should be of immediate interest. These and others are transmitted to the secretary of the New Zealand Geographical Society.

A great measure of the success of the congress was due to the excellent organisation of tours, some of fifteen days' duration, to parts of the country which could only with difficulty have been reached even by the most intrepid geographers working alone. Brazilian geographers who led the tours were as generous of their time as they were redoubtable in coping with back-country emergencies which arose when the Brazilian climate, as if to defy an assembly of world geographers, produced a week of heavy rain and so flood rivers and destroy bridges during what is normally the dry season.

The newly-elected president of the congress is Dr. Ahlmann, the noted Swedish glaciologist and geographer, and the new secretary-treasurer is Hans Boesch of Switzerland. At the invitation of Sweden, Norway, Denmark, Finland and Iceland, the International Geographical Union will hold its nineteenth congress in Stockholm in 1960.—EILEEN FAIRBAIRN

ROXBURGH: PROGRESS REPORT 1956. Although it will be some years before the Roxburgh hydroelectric scheme will be complete, a most important stage was reached in the construction of New Zealand's largest power station when at 2.20 p.m. on July 23, only thirty-eight hours after the first closing of the sluice gates, water was admitted to the turbines and power began to enter the South Island grid.

Where ten years ago an orchard lay along the banks of the Clutha River, today the gorge is barred by a dam ponding back the river in a twenty-five-mile lake that extends to beyond Alexandra. The power scheme when completed will contribute

320,000 kWs to the South Island grid. Technically, the dam is a major engineering achievement for a nation of little more than two million people. Costing an estimated £25,000,000, the dam, powerhouse and spillways contain three-quarters of a million cubic yards of concrete. The bulk of this was used in the construction of the 1,200 feet long dam of mass gravity design which provides for a hydraulic head of 150 feet through the turbines. Although at present only four turbines, generating 40,000 kWs each, are installed, the plan calls for the installation of four more by 1960.

While the 210 mile-long Clutha carries a greater annual volume of water than some of the world's better known rivers including the Nile (or for that matter sixteen times the annual discharge of the Thames), its régime is such that the relatively low winter flow (8,100 cusecs) is inadequate to provide the 3,500 cusecs required for each of the turbine units when the demand for power is at its peak. Effective lake control is therefore essential for a scheme of such magnitude. Lake Roxburgh forms only one of the storage reservoirs of the scheme. There will be limited use of Lakes Wakatipu and Wanaka, where the existing lakeside communities are antagonistic to any considerable variations in lake level. At Lake Hawea the construction of an earth-fill dam and control device will permit the existing lake level to be raised sixty-five feet, thus making Hawea the main controlled reservoir for the total catchment area of approximately 6,000 square miles. The lake regulators will also provide for greater security against flooding—a problem of considerable magnitude in the lower reaches of the Clutha catchment where a spring maximum flow of 117,000 cusecs was recorded in 1878. Together with the direct application of water for power, there are possibilities of further irrigation projects using the summer surplus, while no less direct benefit is likely to accrue to Central Otago from the increased tourist traffic attributable to Roxburgh Dam and Lake and their associated amenities.

Although at present the scheme is only contributing a half of its potential power, the eventual generating capacity will be almost forty-four percent greater than that of the next largest New Zealand station, Maraetai (180,000 kWs), on the Waikato. Yet it may not hold this pride of position for many years; it has already been announced that 1957 will see work begun in earnest on the Benmore Scheme, on the Waitaki, designed to have an ultimate capacity of 350,000 kWs (cf., Grand Coulee: 1,249,800 kWs).

While the contribution of Roxburgh is but a major need temporarily fulfilled, the long term prospects of a power surplus in the South Island must encourage the expansion of existing industries or even the establishment of new enterprises there in preference to the energy-hungry North Island. To many, the first generation of power from Roxburgh brings with it a message of hope for the industrial future of the South Island and a promise of wealth more precious and permanent than from the gold which the Clutha has already yielded.—W. J. Brockie

OTAGO'S PICNIC GOLD RUSH. The story has recently been recounted of how in July 1861, Dunedin, beset by the first feverish grip of gold, made preparations all Saturday for proceeding to the diggings at the fabulous Gabriel's Gully, yet waited until after the Sabbath before setting out (see A. H. Reed: *The Story of Early Dunedin*, Wellington, 1956). It is a wry commentary on the present that, when almost exactly ninety-five years later a similar Saturday evening in July saw preparations for a second gold rush, there was on this occasion no compunction for observing the traditional sanctity of the Otago Sabbath. From all over New Zealand, in what has since been described as the greatest trek in the Dominion's history, some 12,000 cars and 50,000 people—a number considerably in excess of those who toiled along the banks of the Clutha in its heyday as a goldfield—congregated near Roxburgh, on Sunday, 22 July 1956. Since the Roxburgh hydroelectric scheme was first mooted ten years ago, the thoughts of many turned on the chances of discovering one last bonanza when the flow of the river would be interrupted to form the lake behind the dam. Then the normally inaccessible sand bars and pockets of the dry riverbed would be revealed and fossickers might have the chance of finding gold.

As characterises a car-owning nation, the vast majority gathered on those parts of the fifty-mile stretch from Roxburgh to the sea where the road runs close to the river, and wandering around rather aimlessly with fire shovel or humble frying pan in the hope that gold is where you find it, scratched and scrabbled ineffectually in the gravel. On the other hand, the old timers and those of more serious intent sought with resurrected pan, cradle and sluice box, and even in one instance with modern earth-moving equipment, the steep-sided gorges where the presence of stepped outcrops of schist had rendered them immune from dredging activities during the halcyon days of the Clutha goldfield. In such places it was confidently asserted, prospects would be most favourable as the lowest crevices would act as the final gold-collecting riffles of the gigantic natural sluice box washed by the river.

It was the Clutha itself that thwarted the many plans. At no place did the level of the river drop sufficiently for the potentialities of the deep pools beneath the outcrops to be put to the test. Leakage around the dam sluice gates, the flow of the tributaries (particularly the Teviot), and the very considerable volumes of water released from a high water table in the gravel fillings of the valleys, all contributed to the maintenance of a river level only eight to ten feet lower than normal, and, indeed, substantially higher than some recorded winter minima.

With the single exception of a party finding gold that had probably been dropped from a dredge or perhaps from the Miller's Flat bridge many years ago, the reward for the morning's back-breaking toil was, regardless of locale, experience or equipment, never more than a trace of colour in the bottom of the pan. As the day wore on and the gold fever evaporated in the warm winter sunshine, the tension of Otago's modern gold rush relaxed and was replaced by the more tranquil atmosphere of a Sunday afternoon picnic.

Perhaps it was no more than coincidence that the low water level should have revealed the gaunt ribs of the 'Jubilee Dredge', one of the most successful of the Clutha dredges and one reputed to have gleaned a weekly average of almost sixty ounces of gold over a period of thirty-eight weeks. Yet the ghost of many a dredgeman and Chinese miner must surely have chuckled to have seen the ineffective efforts of the mid-twentieth century gold seekers.—W. J. BROCKIE

FARMLAND OR DOMESTIC GARDENS? A controversy has been waged in Britain for many years by those advocating higher density housing development on the one hand and by those recommending lower density development on the other.

It is also a matter of dispute in New Zealand. (See the discussion on a paper read recently by Dr. K. B. Cumberland in R. J. Polaschek [Edit.]: *Local Government in New Zealand*, Wellington, 1956, especially pp. 70-88.)

The protagonists of the one viewpoint maintain that higher housing densities will help preserve the country's farmland and so its food production. Others argue that the fruit and vegetables grown by domestic gardeners from larger housing sections will offset the food lost from the farms taken for housing development. A report published in 1956 by the Department of Agricultural Economics, Wye College, University of London, entitled *The Garden Controversy*, by R. H. Best and J. T. Ward, attempts to analyse the evidence to hand and comes to some conclusions which are strongly in favour of the low density protagonists. (Low density development in the report means from eight to twelve houses to the acre whereas New Zealand densities, on the average, are only four houses to the acre.)

The report concludes that 'it is hard to see how any sound case can be made for the tightening of residential density standards solely, or even principally, on the grounds of conserving food production. It may conceivably be desirable to increase housing densities for financial, architectural or social reasons, but if this is so the arguments for the proposition should be made to stand on their own merit.' Yet some of the assumptions on which this conclusion is based are open to question.

The Garden Controversy is an economic study and the authors have compared farm-gate prices with retail prices for home garden produce. Yet to compare, on a per cultivated acre basis, farm-gate prices with retail prices, gives no idea at all of the comparative quantity, quality or type of food produced by the two methods of land use.

Sample surveys in some British suburbs have shown that fourteen percent of each house section is cultivated for food. However, the report admits that if all land taken for urban development, including streets, shops, schools and playing fields is considered, then possibly only seven percent of all urban land is used for food production. If these seven acres in gardens are expected to compensate for the hundred acres of farmland taken, one is tempted to parody, 'Some gardens! Some gardeners!'

New Zealand readers are warned against accepting too readily the economic conclusions of this report, no matter how right these may be for British conditions. New Zealand, unlike Britain, depends for her wealth on the products from the soil. It is possible, therefore, that economic arguments that pertain in Britain may have little application in this country. [And this would appear to be appreciated by the Town and Country Planning Appeal Board in a number of its recent decisions which have had the effect of preventing hasty subdivision and of restricting 'urban sprawl'. Edit. Note.]—NANCY NORTHCROFT

NEW ZEALAND'S TROPICAL PROVINCE. In the *New Zealand Geographer*, Vol. 6, No. 1, April 1950, p. 84, attention was drawn to the variety of data published by the government in the annual reports of the Department of Island Territories. The *Reports on the Cook, Niue, and Tokelau Islands* for the year ended 31 March 1956 still suffer from many of the defects noted in 1950. There are still no maps; the report on the Tokelau Islands is still slender; there is little interpretation or explanatory discussion.

Nevertheless there is a great deal of useful data on these three contrasting territories. The three coral atolls of the isolated Tokelaus total only 2,500 acres with a population of 1,900 persons. Like any group of low islands in the tropical Pacific, its resources are strictly limited and life is frugal. Apart from the coconut and pandanus, most of the food crops are grown in artificial pits where humus and soil have been laboriously created.

The raised coral island of Nuie is the size of all the islands of the Cook group together, but exports only twenty percent of the fruit of the latter. Less than forty percent is under cultivation, although one third of the island's 22,000 acres is under valuable forest. Of considerable significance to Nuie, and to Auckland in particular, is the substantial number of emigrants whose movement caused a decrease in the island's population during the year under review.

On the other hand, emigration from the Cook Islands has decreased because of the cessation of employment on the phosphate island of Makatea in the Society Islands. During the last five years population has increased about eight percent, which is slightly higher than the years 1945-1951.

A clear indication of increasing interest by the government in the islands is seen in the numerous professional visits by various departmental officials and research staff. The islands are still expensive to the New Zealand taxpayer: annual subsidies to the Cook Islands totalled £300,000; to Nuie £110,000; to the Tokelaus £10,000. The total value of exports from all the islands was only £500,000.—W. B. JOHNSTON

THESES PRESENTED DURING 1956. Nine theses in geography prepared by candidates for the masters degree with honours in the University of New Zealand were accepted during 1956. The theses are now lodged in the libraries of the colleges from which they were presented. The first thesis to be prepared by a geographer for the degree of Doctor of Philosophy in the University of New Zealand was also accepted in 1956. Copies of this work are lodged in the library of Canterbury University College and in the Library of Congress, Washington D.C., U.S.A.

From Auckland University College seven theses were presented:

The North Shore of Auckland, A. S. Black;
The Rural Settlements of the Central Waikato, J. B. Carter;
Maori Land in the Four Northernmost Counties of New Zealand, R. M. Frazer;
Market Gardening in Metropolitan Auckland, D. T. Hunt;
New Zealand About 1911: A Land Transformed, E. E. Owen;
The Auckland Water Supply, Ann D. Stephen;
Horowhenua Agriculture: Its Character, Forms and Distribution, C. P. Walker.

From Canterbury University College two theses were presented:

The Agricultural Lime Industry of the South Island, L. J. King;
The Contemporary New Zealand Town: A Study in Urban Geography, L. L. Pownall (Ph.D. thesis).

From Victoria University College one thesis was presented:

A Study of Diurnal Variation of Rainfall in New Zealand, W. J. Maunder.

IN OUR CONTEMPORARIES

1. *In New Zealand Journals . . .*

A Classification of Land Use

LAND-USE SURVEY. GENERAL PRINCIPLES AND A NEW ZEALAND EXAMPLE: James W. Fox. Auckland University College. *Bulletin No. 49,* Geography Series No. 1, 1956, pp. 46.

The publication of this bulletin could not be more timely. The population of New Zealand is increasing fast—so fast, indeed, that it is unlikely that our export income will be able to keep pace with the rapidly rising population. From economists, planners and administrators there are repeated appeals for a national resource survey. Basic to any such survey is an inventory of present land use.

This bulletin is in three parts. After briefly outlining the history and defining the nature and scope of land use, Mr. Fox describes in detail a classification of rural land use and the 'principles of wholeness of taxonomic categories' on which it is based. Finally there is a short chapter on the evaluation and application of land use covering techniques of analysis, correlation with data mapped quantitively, its proved value in Britain and the United States, and the urgent need for such an objective survey in this country.

The classification is based on a hierarchy of dependent categories. The principles on which these are based demand, 'first, that in any classification of land use, the differentiating characteristic must be applied to the complete range of land-use classes since every category must embrace this complete range and must evince in its classes the same degree of analytical detail; and, second, that a differentiating characteristic employed in one category cannot be used again to differentiate the classes in another category.' Mnemonic symbols, which are composed of letters constant in meaning, make the classification easy to understand. There is constancy in the meaning of the symbols, in colouring and in the technique of representation. The classification has been checked in the field at various stages of development over a number of years, and the author can justly claim that it is 'logical, coherent and comprehensive'.

No review of land use would be complete without some comment on the World Land Use Survey, which is criticised by Mr. Fox on the grounds that 'the level of abstraction of classes . . . varies, thereby marring the logicality of the classification'. Plans for a world survey would be facilitated by the successful prosecution of national surveys.

However, land-use survey is but a primary technique. Of much greater importance is the analysis and interpretation of the single-topic maps which can be abstracted from the original. The author stresses the particular contribution the geographer can make in the final evaluation and notes the achievements to date in the application of the geographic approach in Britain, the United States and Europe.

The need for such an objective survey of land use is urgent. To date, only a small part of New Zealand has been covered by land-use surveys, most of which have had limited objectives. A survey of dominion-wide scope is called for as part of a national stocktaking necessary for the integrated economic development of this country. Aside from the practical solution it presents to the problem of mapping the land use of New Zealand, this statement is a valuable contribution in the field of systematic literature and should serve to eliminate much of the confused thinking on this topic.

—JOYCE K. BEWLEY

2. *In Overseas Journals . . .*

GROWTH PATTERNS OF NEW ZEALAND TOWNS

EVOLUTION OF THE URBAN STRUCTURE OF NEW ZEALAND: L. L. Pownall, *Tijdschrift voor Economische en Sociale Geografie,* Jaargang 47, No. 3, Maart, 1956, pp. 63-68.

'The urban structure of New Zealand', writes Dr. Pownall, 'is dominated by the four large centres of Auckland, Christchurch, Wellington and Dunedin, each of which has more than 90,000 inhabitants. These towns are widely separated in population numbers from the ten urban areas of next highest rank of 19,000-34,000, and these in turn stand out above the large majority of the urban centres which are of less than 12,000 population.' The aim of this article is to show how this hierarchy of distinct and separate groups has evolved. To this end the author has constructed hierarchical graphs at approximately ten-year intervals; four of the graphs are published here. These graphs have a logarithmic population scale on the vertical axis and towns are plotted by size and rank. Breaks in the line of dots are used to differentiate four ranks: major cities, cities, major towns and towns.

The first of the published graphs, for 1901, shows the results of sixty years' urban development. The four main centres, with 50,000-70,000 people, are classed as 'cities', and there are forty-five 'towns' with 1,000-10,000 inhabitants. The clear-cut pre-eminence of the four cities is attributed to their early start, their possession of the most useful harbours, and to the fact that they were too far apart to compete with each other in their formative years. The accompanying map shows that the 'towns' were most numerous along the east coast of the South Island and in the southern half of the North Island. In the whole of the Auckland province there were only four.

The rapid development of the Waikato region, after 1901, as the dairying industry gathered momentum, soon made good this dearth of small towns in the north. It also caused Auckland to grow so much faster than the other cities that on the graph for 1911 it is classed as a 'major city'. The category, 'major town', also appears for the first time on this graph, to describe a group of ten regional centres that had 'broken off from the upper level of the town group'. The break occurs on the graph at about 8,000 and the largest 'major town' had some 16,000 people. On the 1921 graph, the group extends from 10,000 to 23,000 and the break has grown wider. Within the category of 'towns' this graph reveals a distinct group at the 4,000-5,000 level. Dr. Pownall attributes both these developments to the advent of the motor car, which gave 'a new impetus to the better located and well-established sub-regional market centres. . . .' In 1911, he calculates, there was one motor vehicle to every 200 or so of the population; by 1921 the ratio was 1 : 20. In 1931 it was about 1 : 6; in 1951, 1 : 4.

The revolution in transport wrought by the motor car has had profound effects on the urban hierarchy, as may be seen from the graph for 1951. The four main centres have expanded so much that Dr. Pownall now calls them all 'major cities', even though Dunedin still has fewer people than Christchurch had while still a 'city', and even though the gap between Auckland and the others has grown steadily wider. 'Within the next fifty years', we are told, Auckland 'may well emerge as a super-city'.

The ten centres of the second rank, which range from 19,000 to 34,000, remain a remarkably homogeneous group and one wonders why Dr. Pownall has felt it necessary to discriminate between the four largest, all over 29,000, and the other six, with populations under 25,000. He promotes the four to 'city' rank, leaving the others as 'major towns'. To call Palmerston North and Wanganui 'cities' and New Plymouth a 'major town' is not even consistent with his own treatment of these centres (as equal and comparable) in his 'Town and Region' study, published in 1953 (*N.Z. Geographer,* Vol. 9, No. 1, April 1953, pp. 1-16). It is also debatable whether or not any of these ten is yet a fully-fledged 'city'. Might it not have been better to class them all as 'minor cities'? This would have emphasised the gulf between the 'major cities' and the rest, and would have left the term 'major town' free to be used lower down the scale, where there is an urgent need to subdivide a 'town' class that now embraces more than eighty centres. The most obvious break on the graph, below 12,000, occurs between 5,900 and 7,000 and is at least as significant, on the logarithmic scale, as that between 25,000 and 29,000. Above this break there are eight centres, all worthy by any standards of the title 'major town'. They are, in fact, the more successful members of the group that could be distinguished at the 4,000-5,000 level in 1921. Dr. Pownall admits that there may be a new class emerging, but only Whangarei, he thinks, 'will arise in the forseeable future as a major town or city'. Not everyone will agree with him, least of all the citizens of Tauranga, Rotorua, Masterton and Ashburton.

Despite some shortcomings this article affords a useful outline of the main trends in New Zealand's urban development and one hopes that the author will delve further into this important subject.—J. S. DUNCAN

GEOGRAPHY FOR BACHELORS

THE PATTERN OF SEX RATIOS IN NEW ZEALAND: S. H. Franklin, *Economic Geography,* Vol. 32, No. 2, April 1956, pp. 162-176.

As a part of a wider investigation into the demographic character of communities in New Zealand, this study seeks to reveal regional differences in the pattern of sex ratios. The author defines a community as a group of people possessing a common way of life, utilising a particular type of environment; its size may vary from a large urban group to a tiny rural one. He claims that there are advantages in examining communities as a means of understanding the interrelationships between man and the land. A community is a measureable unit; it is relatively homogeneous; it may be studied in detail in the field, and by analyses of such sections of reality it is claimed regional characteristics can be recognised.

Population is distributed in communities; while its residential and occupational distributions are fundamental, other significant aspects are age structure and sex ratio. The sex ratio is simply the statistical relationship between the numbers of females and males of the population. Sex ratios are shown to vary according to historical and economic influences upon settlement, and these variations are found to reveal significant regional patterns.

Mr. Franklin describes the contrasts found between the sex ratios for the European and the Maori communities. The Maori population shows a better balance between the sexes in rural areas than the European. Where pioneer aspects of farming prevail, and store sheep and cattle raising are the characteristic occupations among European communities, a high degree of masculinity is found. Inaccessibility and the economy of sheep ranching are associated with such conditions over much of the Central Plateau of the North Island, and of the East Coast uplands. Intensive forms of agriculture are associated with above-average sex ratios.

Urban areas in all western European countries have characteristically more females than males. For different towns, however, variations occur due to differing opportunities for employment: coal mining and freezing works are associated, for instance, with a lower than average urban sex ratio. There is clearly an overall migration of females from country to town, for social and employment reasons. Inaccessibility and lack of amenities, together with opportunities for employment, provide the 'pull' to urban areas in New Zealand.

The author examines some social and demographic characteristics associated with sheep farming, dairy farming, village and suburban communities, but only in general terms and without specific examples. Two maps, of the North and South Island rural sex ratios, on a county basis, are included, but only the broadest conclusions are possible from these, because the county is a very inadequate unit for refined analysis of regional patterns. Two maps, for 1911 and 1936, are included to demonstrate that a more balanced sex ratio has been recorded as regions develop economically, and as isolation is broken down.

This study is welcomed as a step towards a detailed, systematic study of population. Although Mr. Franklin is conscious of the inadequacy of the statistical material for his purpose, his article contributes to the search for precise bases for regional differentiation. There is an immense field of material in social and economic conditions for such researches—some avenues offering material of greater geographic significance than others—but all should provide some new material in themselves and at the same time confirm or modify the broad features of New Zealand geography that have so far been sketched in during the course of the past two decades.—R. G. LISTER

FARMING IN FIJI

AGRICULTURAL DEVELOPMENTS IN FIJI: W. J. A. Payne and R. R. Mason, *World Crops*, Vol. 8, No. 5, May 1956, pp. 187-191.

After a brief introduction of the colony, its position, climate, vegetation, mixed population and system of land tenure, Messrs. Payne and Mason, who are officers of the Fiji Department of Agriculture, turn their attention to the colony's agriculture. That agriculture is Fiji's major industry. The economy depends largely upon the export of sugar, copra or coconut oil, and to a lesser extent, bananas. Unfortunately Fiji has been unable to maintain the volume of agricultural exports in proportion to the rise in population, and the volume and value of food imports has grown considerably. The department is principally concerned with increasing production, widening the range of crops upon which the economy depends, and encouraging the Fijians to utilise their land.

Most of the research and extension work has been designed to cover these three matters. Brief descriptions are given of such work. It includes a soil survey, the control of the rhinoceros beetle, the selection of a site for a coconut research station, the improvement of rice varieties and mechanisation of cultivation, improvement of banana yields, root crops and pasture and livestock investigation. Under the heading 'extension work' passing reference is made to plant introductions, the establishment of a cocoa industry and of work in soil conservation and weed control. The extension work of the department is, of course, very important and deserves more space. Weeds and their control are, for example, hardly mentioned even though much valuable information has been obtained on modern control methods, and the use of weedicides is becoming common practice.

The Fiji Department of Agriculture, since its establishment fifty years ago, has accomplished a great deal, but in many instances the agriculturalists of the colony have not utilised the available information to the full extent. To increase and supplement the economy it is essential that the range of crops upon which the economy depends should be widened, that the native land be properly developed, and that the information made available by the research and extension officers of the department be appreciated and utilised.

'Agricultural Developments in Fiji' presents a useful summary of much of the work being carried out in the colony. The article is illustrated with photographs and there are several worthwhile tables. Unfortunately there is no map showing the areas at present occupied by the main crops.—J. W. PARHAM

GERMAN INTEREST IN NEW ZEALAND

The January-February 1956 issue of the journal of the German Institute of Foreign Relations (*Institut für Auslands-beziehungen*) is devoted to New Zealand. Here are fifty large double-column pages of text (in German) in the form of seventeen essays on the geography, history and economy of the dominion; on art, drama, music and literature; and on German links and connections with New Zealand. There is a brief chapter by Ronald Lister on 'New Zealand—a World in Itself' and by M. Y. Walls on 'Economic Foundations'. But in the first two sections there is little that is new. More original is the third section, especially those too-brief essays in it on 'Germans in New Zealand' and 'New Zealand in German Literature'. This last chapter is accompanied by a bibliography of material on New Zealand in German. It is a pity that German readers, for whom this journal is intended, could not have been provided with even a short list of titles of works on New Zealand by New Zealanders

THE FUTURE OF TROPICAL AUSTRALIA

THE CHALLENGE OF TROPICAL AUSTRALIA: R. H. Greenwood, *Pacific Affairs,* Vol. 29, No. 2, June 1956, pp. 126-140 (Part I), and Vol. 29, No. 3, September 1956, pp. 223-242 (Part II).

Mr. Greenwood's inventory and prospect of development and settlement in tropical Australia has many points of agreement with the appraisal of the situation which resulted from the symposium of the Twentieth Summer School of the Australian Institute of Political Science at Canberra in 1954-1955, the proceedings of which were published under the title *Northern Australia: Task for a Nation* (see review, *N.Z. Geographer,* Vol. XI, No. 2, October 1955, p. 207). But whereas the earlier review approached the question from a systematic or topical viewpoint, this long article adopts a regional approach.

Both in his review of present achievements and future prospects, and in stating his opinion that the defensive attitude of Australians about this area is insupportable, Mr. Greenwood insists that Northern Australia is not the only sparseland in the world. Such areas exist also in Canada, Brazil, China and the U.S.S.R. without a great deal of national anxiety. He reminds us that uneven distribution of population is one of the dominant features of the world's human geography and that Australia is therefore not unique. An appraisal of the environment of Northern Australia makes it doubtful if denser population would have followed settlement by other peoples, for the age-long migration through southeast Asia found no attraction in the inhospitable shores with which Australia faces Asia. From the viewpoint of defence, the empty north can be rated a strength rather than a weakness. Australian sensitivity concerning the empty north is considered emotional rather than rational. It is based on the unique population gradient between Australia and Asia. The situation, the author suggests should be eased, not by an alteration in this population gradient, but rather by an alteration in the equally steep economic gradient.

The challenge of tropical Australia, therefore, is seen as an economic rather than a political issue. Having reviewed the broad physical background and disposed of the political issues, the author reviews progress to date, and points to trends which will affect future development in tropical Australia. Regional contrasts are drawn between the lowland corridors and plains of the east Queensland coast, the range and basin country of the sheep and inner cattle belt of Queensland, and the extensive 'outer crescent' of beef cattle rearing and isolated but rich mining areas.

The effect of suggested development in one field of economic activity on other fields is fully investigated. Development in the north, the author argues, cannot be considered in isolation, but rather as one part of the development of Australia as a whole. Industrialisation and rural expansion in the southern part of the continent must create needs which the north can satisfy, though in meeting the challenge of tropical Australia enthusiasm 'must be tempered by the sober facts of physical geography and demand patterns which indicate that the population potential of extratropical regions far outweighs those of the tropics'.—A. D. TWEEDIE

Research in the Antarctic

ANTARCTICA IN THE INTERNATIONAL GEOPHYSICAL YEAR.

Geophysical Monograph No. 1, American Geophysical Union, Washington D.C., 1956, 133 pp., map.

This useful publication is based on an Antarctic symposium planned to provide up-to-date contributions on all aspects of scientific research in Antarctica for the use of members of I.G.Y. parties to Antarctica. The plan is essentially practical and the contributions are concise and authoritative. The veteran geologist, Laurence M. Gould, who was chairman of the Symposium Committee and one of the editors, has not included his own contribution but he clearly deserves credit for good judgment in the selection of authors and the presentation of their papers.

There are two general papers, by Joseph Kaplan and H. Wexler, on the American I.G.Y. organisation and the Antarctic programme of all the nations involved. A section on Antarctic geography is introduced by Paul Siple, an experienced explorer, who has been selected to take charge of the United States station at the South Pole itself. He succeeds in just over four pages in presenting a general impression of the nature of the continent of Antarctica and its surrounding waters, and concludes that the forthcoming glacial and seismic programmes will provide a more accurate concept than ever before, and that furthermore 'it is likely that the Antarctic will never again be unpopulated, even though the geopolitical rivalry for national territorial claims will no doubt continue for many years to come'.

When contributions are as diverse as these are, the limits of a short review give little scope for summarising them. Glaciology and meteorology are dealt with ably by R. P. Sharp, H. Wexler and M. J. Rubin. There is also a useful summary by John Roscoe of Antarctic photogeography, in which he points out that already an appreciable portion of the continent has been covered by reconnaissance aerial photography, and claims that more reliable and detailed information is available from today's air-photos than from existing maps. Four competent geologists, W. E. Davies, Duncan Stewart, Maurice Ewing and B. C. Heezen deal with this important field, while the newer subject of upper atmospheric physics is covered by E. O. Hulbert ('Geomagnetic Disturbances'), A. H. Shapley ('Ionospheric Conditions in the Southern Auroral Zone'), E. H. Vestine ('The Aurora Australis and Related Phenomena'), J. A. Simpson ('Cosmic Ray Experiments of Recent United States Antarctic Expeditions').

Biological studies will be a subordinate part of the work of expeditions in the I.G.Y., but the opportunity offered to carry out much-needed studies has been recognised. Articles on Antarctic fauna by Carl R. Eklund and botanical research by George A. Llano conclude the symposium, the latter breaking some new ground and providing a welcome summary of the problems of cryptogamic botany in Antarctica.

As summaries, the various contributions are inevitably uneven, but they all include useful bibliographies and practical suggestions for future work on outstanding problems. The new map in stereographic projection (scale at 71°S. is 1 : 6,000,000) is probably the largest yet published on a single sheet.

The publication ranks with the *Antarctic Manual* (1901), *Some Problems of Polar Research* (1928), and *The Antarctic Today* (1952) in marking a milestone in the summarising of Antarctic research.—R. A. Falla

History of the Far North

THE STORY OF NORTHLAND. By A. H. Reed. Wellington: A. H. and A. W. Reed, 1956, pp. 395.

One cannot pass through Northland today without seeing its swiftly changing landscape, its signs of vital growth, and its still obvious relics of an exciting past. A. H. Reed has already made two valuable contributions to the growing literature of this region, *The Gumdiggers* and his monumental *Story of the Kauri*. Now (at the age of eighty-one years) he brings us an informal and robust account of much that happened in Northland from the beginnings of European contact to the early years of this century.

Today Northland is an area of rapid expansion. Extensive areas of hitherto unused gumland are being converted to high producing sheep and dairy pastures and secondary industries are moving into the growing rural towns. But it is a new prosperity for after an eventful forty years' contact with the most diverse elements of European society, from whaler and publican to missionary and teacher, the development of Northland received a heavy blow with the removal of the capital from the Bay of Islands to the Waitemata. The close of the first Maori War in 1845 saw the beginning of neglect, roadless isolation and obscurity. It is in describing this period that Mr. Reed is at his best. In a series of short deft studies we are given an often vivid picture of the grim struggles for survival that faced the early settlers. The Maori-pakeha relations, often good but at times extremely difficult, are described honestly and sympathetically.

European settlement in the north would have been sparse indeed in the nineteenth century had it not been for the kauri and its fossil gum. Here, of course, the author treads familiar ground, but his short descriptions of place and people are valuable. One wonders, after reading these descriptions of the kauri timber industry, if there is to be found any clearer example of spendthrift folly than in the desecration of our magnificent kauri forests.

Although they are not detailed, the sections of the book dealing with the special settlements of the Scots at Waipu, the Bohemians at Puhoi, and the Nonconformist groups who settled on the Kaipara, at Wellsford, Maungaturoto and elsewhere give us a picture of Northland in the middle nineteenth century. The account of the settlers at Puhoi, speaking no English, living in isolation, struggling without any financial resources against sub-tropical forest and the intractable gumland soil, and yet to emerge as a prosperous community with high producing pastoral farms, is the best of these studies. Valuable too, is the account of Northland's early industries: not only timber milling and gum digging, but the manufacture of flax (some twenty small mills were operating in 1870), the mining of coal, copper, manganese and limestone. But in places this latest Reed book reflects the many-sided and sprawling nature of the subject. Scant attention has been paid to the Maori and European settlements north of Whangarei after 1845. Again, simple maps showing the main areas of European and Maori settlement and of the industrial activities would have added greatly to the appeal of the text. The simple place map on the inside cover is cartographically inadequate. Yet this book is a most valuable and interesting record of events in this once neglected region. It is a work with a distinctive flavour, written by a man sensitive of human values and possessing a sympathetic understanding of the land where he spent his youth.—K. A. HART

AN UNFORTUNATE CONSERVATION PLEA

LAND OF TANE: THE THREAT OF EROSION. By Richard St. Barbe Baker. London: Lutterworth Press, 1956, pp. 142.

Mr. Baker's visit to New Zealand for a few weeks in 1954 was, he says, 'a heart-rending experience'—because he saw in the high country of Otago what he 'had witnessed in the Sahara' and in the North Island 'a disorganised system of agriculture which, if persisted in, will lead rapidly to dust-bowl conditions'. But if the visit was an anguish, the book is a torture. Rarely has so important a cause (the conservation of forest and soil) been done so grave a disservice.

The book was written on the ship going home (p. 97) and apparently compounded from casual observations, hastily scribbled notes and a fund of near-mystical ideas and beliefs. How else could these mistakes arise? Chinemari (p. 77) presumably for Ohinemuri; Peter Revee (p. 76) for Pember Reeves; Hoc*k*stetter for Hochstetter; Arowh*i*nua for Arowhenua; Wai*f*iate for Waipiata; *Rimu podocarpus totara, Dacrydium cupressinae* and *Phonium tenor* for botanical names of totara, rimu and New Zealand flax; Cockane for Cockayne, etc. etc. How could other than a mystic write 'The vegetation . . . is the primary principle of the bi-polarity of the great interplay between earth and cosmic ether space' or 'the vegetative covering of the earth . . . is the intermediary in rythmic counter-poise in the interplay between its outside and inside'?

Mr. Baker knows so little of the work of the New Zealand Forest Service and of the Soil Conservation and Rivers Control Council (which he inaccurately refers to as the 'Department of Forests', the 'Forestry Commission' and the 'Soil Service') that he could wish that the former knew its duty (p. 64) and that the conservation movement in New Zealand was more than ten years old.

New Zealand readers will be surprised to learn that the fourteenth century Maoris 'felled' forests, made 'farms' and 'reaped' crops (p. 101); that Murupara is a model township of 2,000 people (p. 131); that a farmer at Tiroitt [*sic*] has '*pioneered* in making shelter belts around his home' and is 'pioneering in planting trees around his fields and pastures' (p. 75); that, but for Mr. Baker, we would have no New Zealand Forest Service (p. 59); that in 1954, far from being grateful, 'this same service had the temerity to oppose my [Mr. Baker's] considered opinion'.

On the other hand, New Zealanders will be immensely relieved to know that 'they might yet be able to save their country and, therefore, themselves'. Presumably by bringing Mr. Baker on another (less 'heart-rending') visit, by planting trees everywhere and indiscriminately, by the magic process of 'restoring' trees to South Island mountain sides which never knew them, and by importing 20,000 migrants to become mobile planters of trees. In this way, with trees everywhere, 'instead of six acres to one sheep, there would be six sheep to one acre'. Unfortunately, whilst the present generation of New Zealanders has a great respect for trees, it is pretty hard-headed, and can have little time for Mr. Baker's abstruse and occult 'wings of salvation', 'bio-sylvics' and 'positive and negative bi-polarity'.

The book is beautifully illustrated with photographs of trees in New Zealand and four of the author, including one on the misleadingly attractive dust-jacket.

Maps for New Zealand Schools

PHILIPS' NEW WALL MAP OF NEW ZEALAND IN TWO SHEETS.

Edited by Kenneth B. Cumberland. Geo. Philips, London, 1956.

Philips have published as part of their comparative series of smaller school maps two new wall maps on a scale of 1 : 1,000,000, one of the North Island of New Zealand and the other of the South Island. The maps have been edited by Kenneth B. Cumberland, Professor of Geography, Auckland University College, and are a most useful addition to intermediate and post-primary school equipment. They present general landform features in five strong colours, together with the main cities, towns and railways. Each sheet has a large and valuable inset map showing land use and, also, the locations of coal deposits, hydroelectric stations, and air and ferry routes.

These maps have many virtues. In the first place, in presenting surface configuration, emphasis has been placed upon the prevailing character of the landforms rather than upon elevations above sea level. Thus, in the division of the configuration into five simple categories something far more realistic than usual has been achieved.

In the second place the maps show every town or city of over 1,000 population according to the 1956 census. Furthermore, the latest census figures have been used in order to differentiate cities and towns into five categories in terms of their population. By the simple device of a symbol beside the name of each place, one can see into which group it falls. Teachers may perhaps wish that six, not five, categories had been resolved, insofar as the wide range between 10,000 and 50,000 puts places such as Wanganui and Gisborne into the same group, whereas Wanganui has today approximately 10,500 more inhabitants than has Gisborne.

In the third place, the insets add a great deal to the total value of the sheets. Having no lettering on the actual surface of these smaller maps (one inch representing $33\frac{1}{3}$ miles), but relying upon a clear colour and symbol key, they are read easily. Moreover, they provide up-to-date information not found on other available wall maps of New Zealand. To see quickly where are the remaining wastelands, the native bush, the exotic plantations, the sheep lands, dairying areas and the location of mixed farming is of real practical use, and all teachers will welcome this help.

The main point of criticism is in regard to the statement of scale. Mathematicians will not be pleased to find the scale of 1 : 1,000,000 alternatively stated as 1 inch = approximately 16 miles. Acceptable forms are: 1 inch represents 16 miles approximately, or 1 inch to 16 miles approximately. The = sign should not be used. However, these are two excellent maps which all teachers of geography will find they need.

—A. M. GORRIE

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TO CONTRIBUTORS

Members of the Society and subscribers to the *New Zealand Geographer* will have noticed that the journal does not always appear during the months of April and October. Every endeavour is made to publish the *New Zealand Geographer* in time, but the Editor is largely in the hands of contributors. The work of editing and publication would be greatly facilitated and expedited if the following points were noted:

1. All copy intended for publication should be in the hands of the Editor by the beginning of October for the April number, and by the beginning of May for the October number. Late copy can be accepted only in special circumstances. Alternatively, it may be held over.

2. Articles, notes, commentaries and reviews should be typed, double-spaced, on quarto paper.

3. Maps and diagrams must be drawn in indian ink and be ready for reduction. Their dimensions must be of a reasonable order and should not be more than three times the page size of the *New Zealand Geographer.*

4. Photographs must be printed for contrast on glossy paper.

5. As far as possible, contributors should follow in their footnotes, captions and lettering the established style of the journal.

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